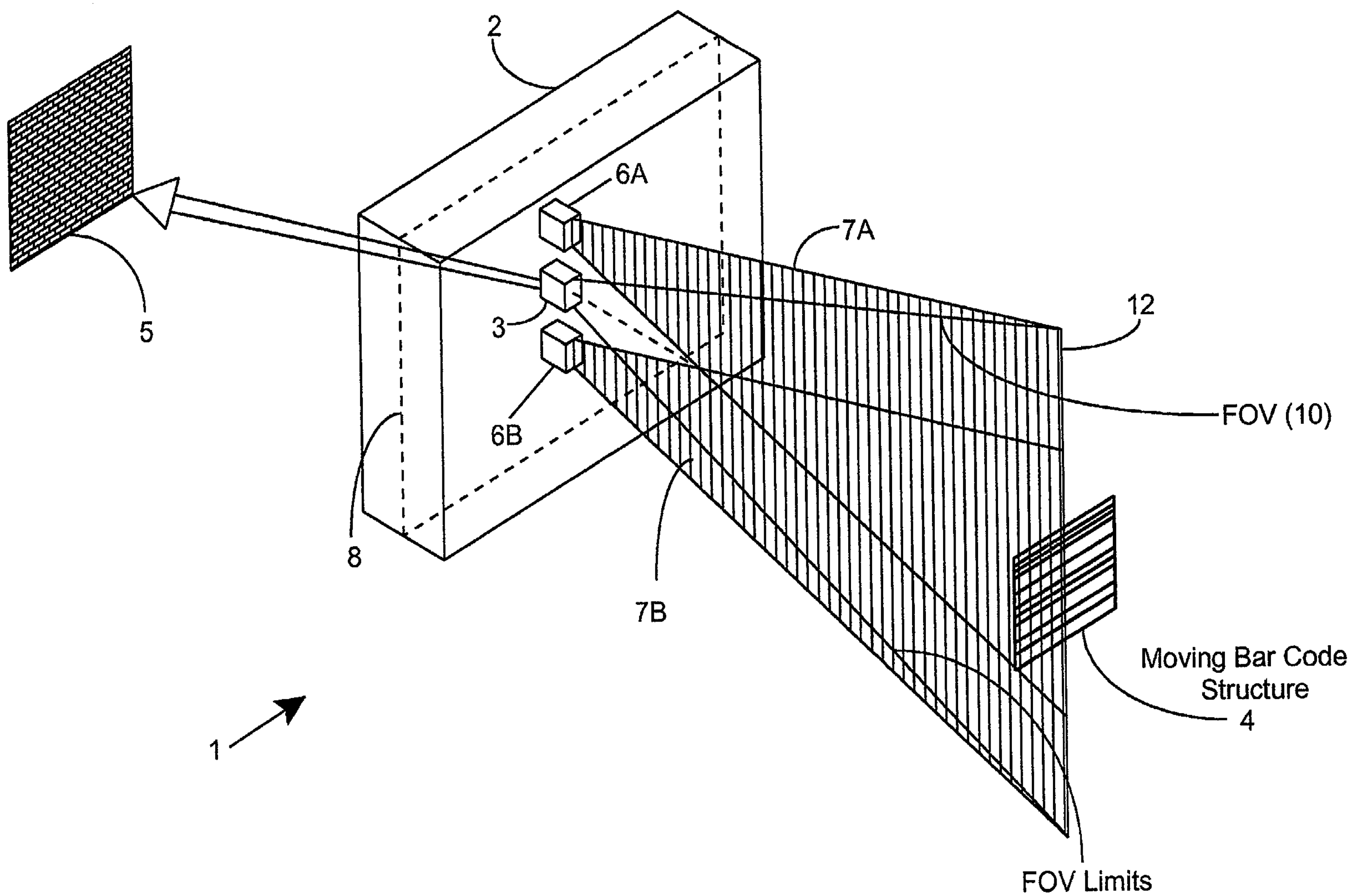

2
6A
7A
5
3
12
FOV (10)
6B
8
7B
Moving Bar Code
Structure
4
1
FOV Limits

FIG. 1A

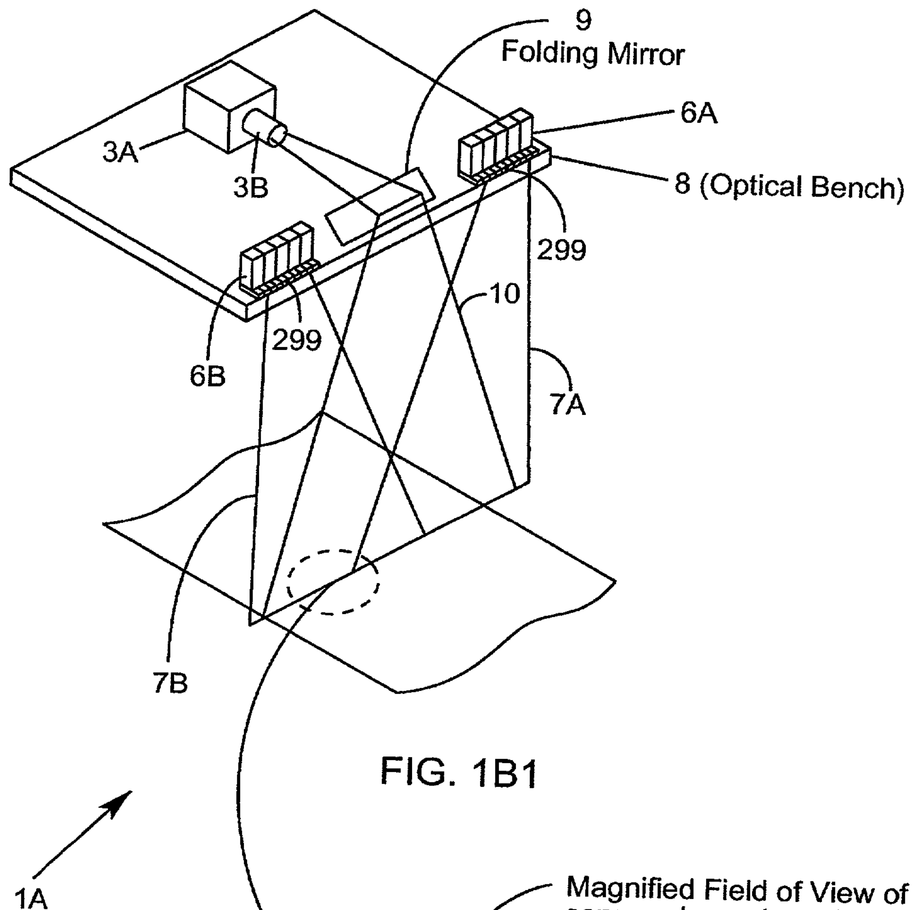


FIG. 1B1

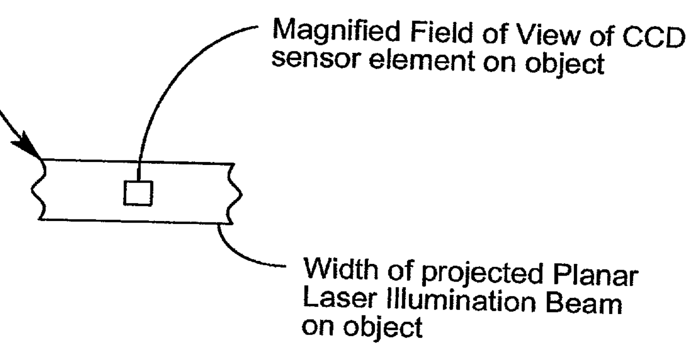


FIG. 1B3

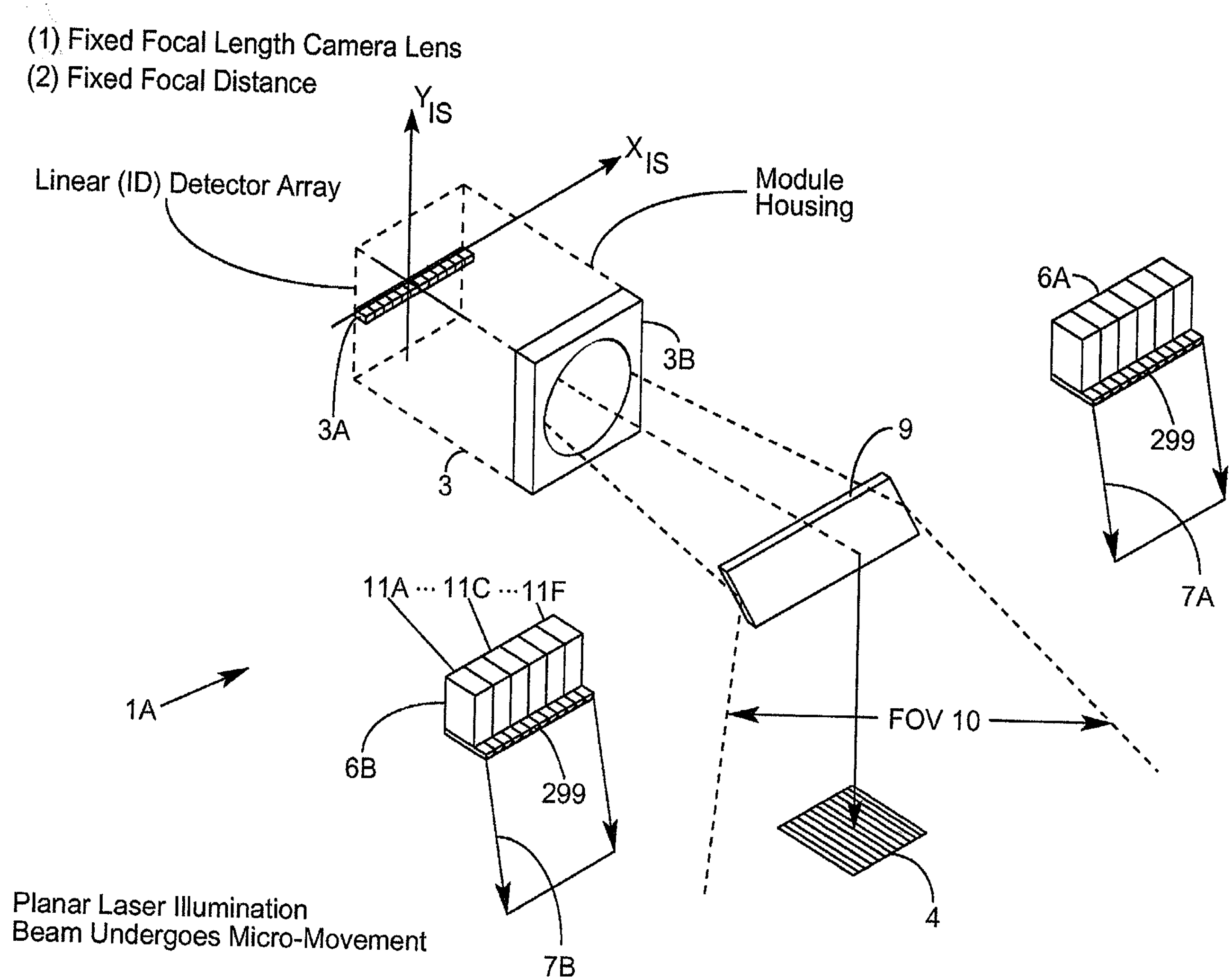

(1) Fixed Focal Length Camera Lens
(2) Fixed Focal Distance
Y_{IS}
X_{IS}
Linear (ID) Detector Array
Module
Housing
6A
3B
299
3A
9
3
7A
11A ··· 11C ··· 11F
1A
FOV 10
6B
299
Planar Laser Illumination
Beam Undergoes Micro-Movement
7B
4

FIG. 1B2

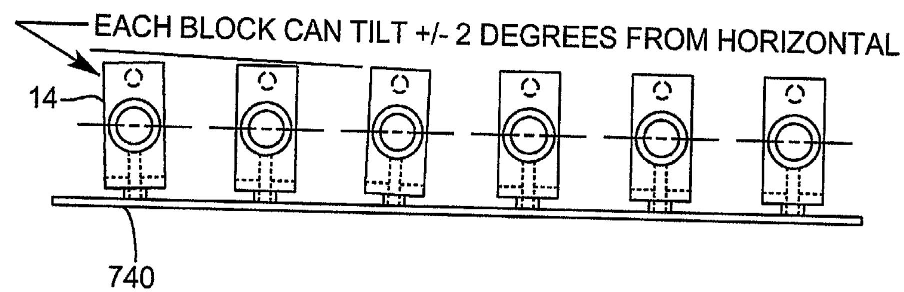


FIG. 1B4

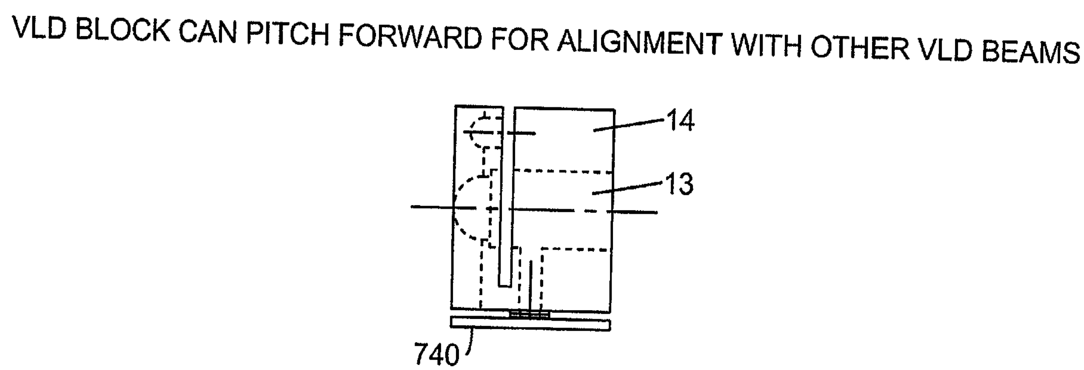


FIG. 1B5

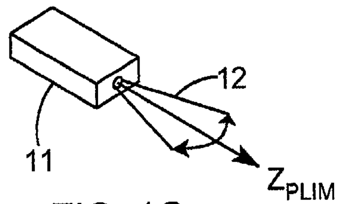


FIG. 1C

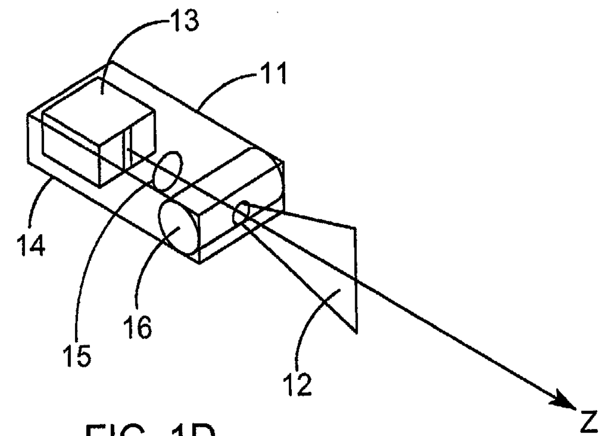


FIG. 1D

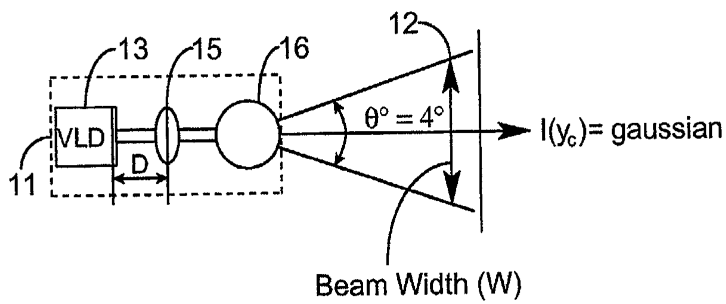


FIG. 1E1

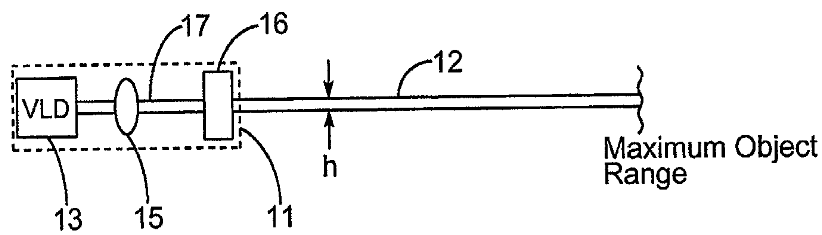


FIG. 1E2

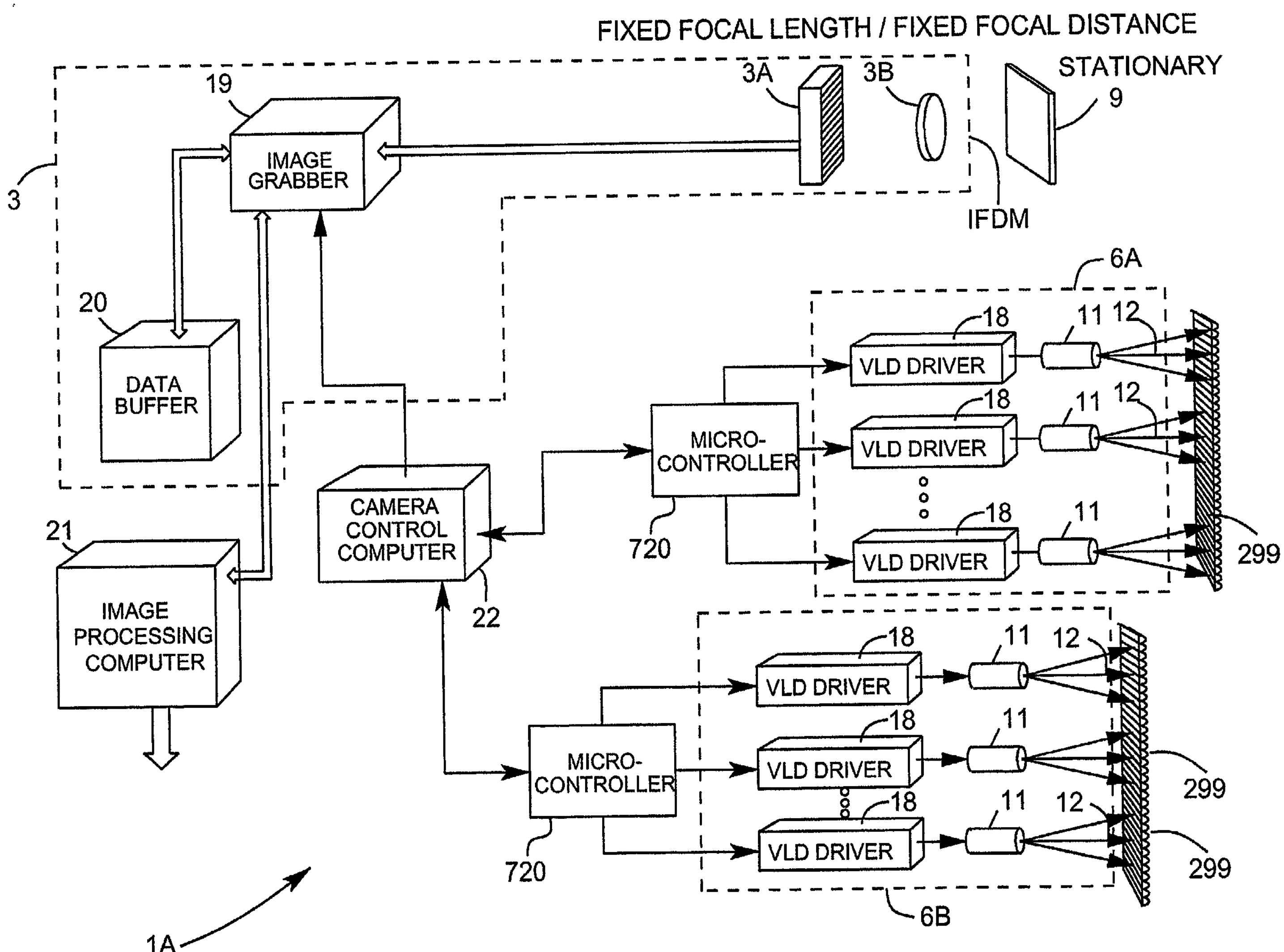

FIXED FOCAL LENGTH / FIXED FOCAL DISTANCE
STATIONARY
9
3A
3B
IFDM
3
19
IMAGE GRABBER
20
DATA BUFFER
21
IMAGE PROCESSING COMPUTER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
720
MICRO-CONTROLLER
720
6A
6B
VLD DRIVER
VLD DRIVER
VLD DRIVER
VLD DRIVER
VLD DRIVER
VLD DRIVER
18
11
12
299
1A

FIG. 1F

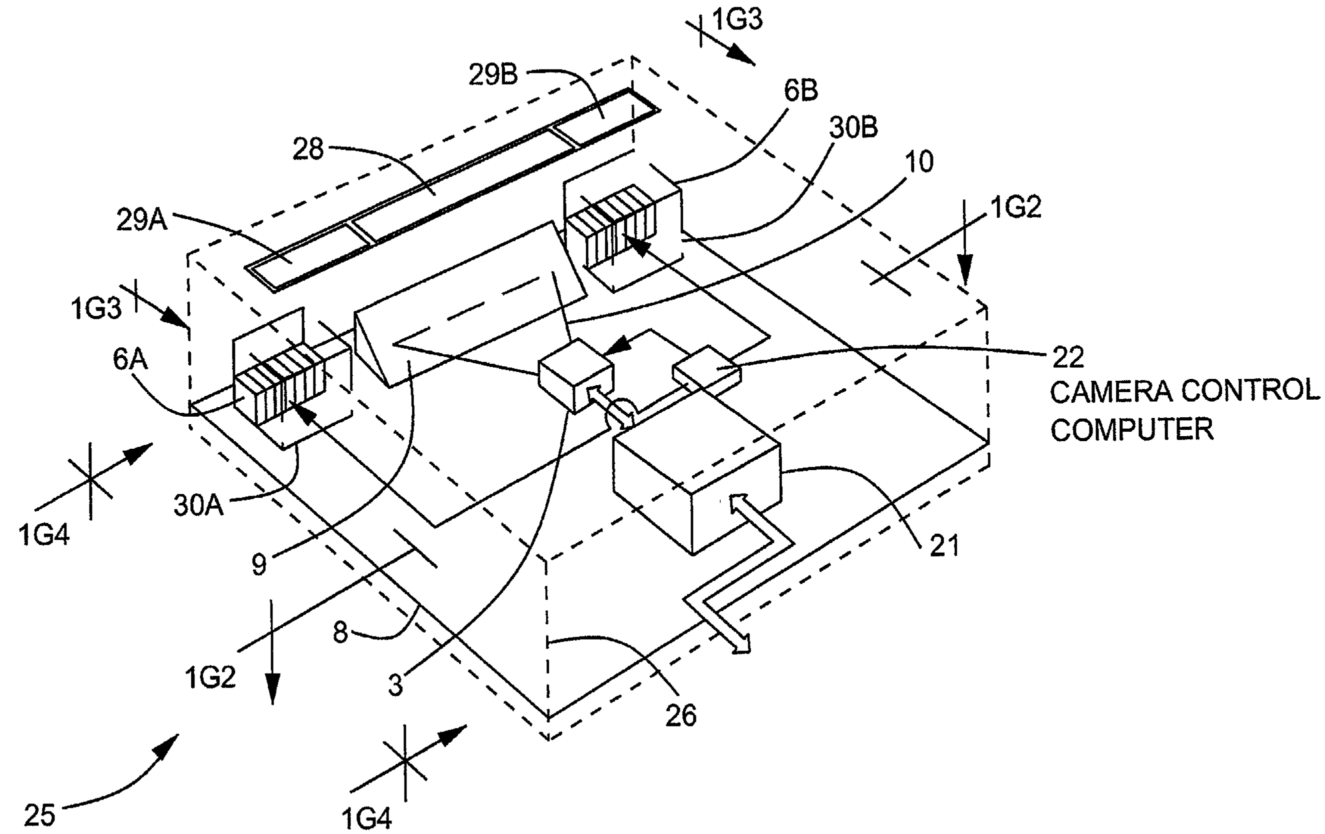
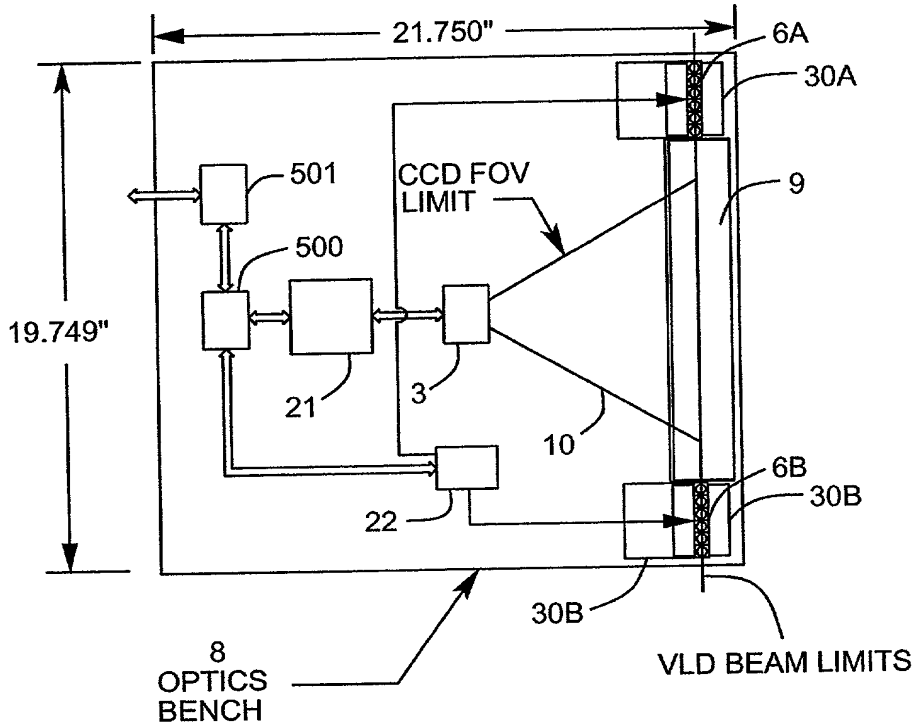

1G3
29B
6B
30B
28
10
29A
1G2
1G3
6A
22
CAMERA CONTROL
COMPUTER
1G4
30A
21
9
8
1G2
3
26
25
1G4

FIG. 1G1



21.750"
6A
30A
501
CCD FOV
LIMIT
9
500
19.749"
21
3
10
6B
30B
22
30B
8
OPTICS
BENCH
VLD BEAM LIMITS

FIG. 1G2

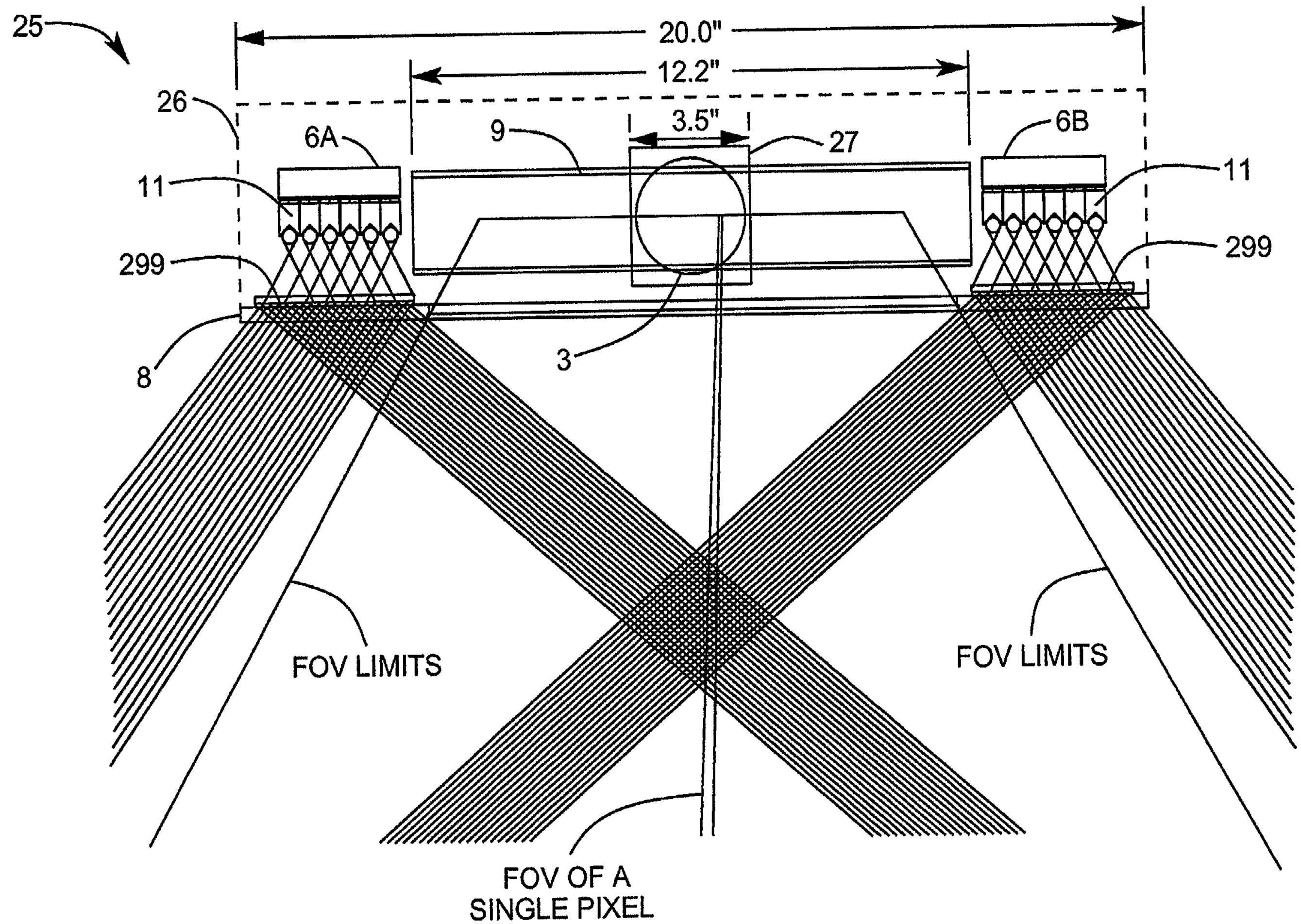

25
20.0"
12.2"
3.5"
26
6A
6B
9
27
11
11
299
299
8
3
FOV LIMITS
FOV LIMITS
FOV OF A
SINGLE PIXEL

FIG. 1G3

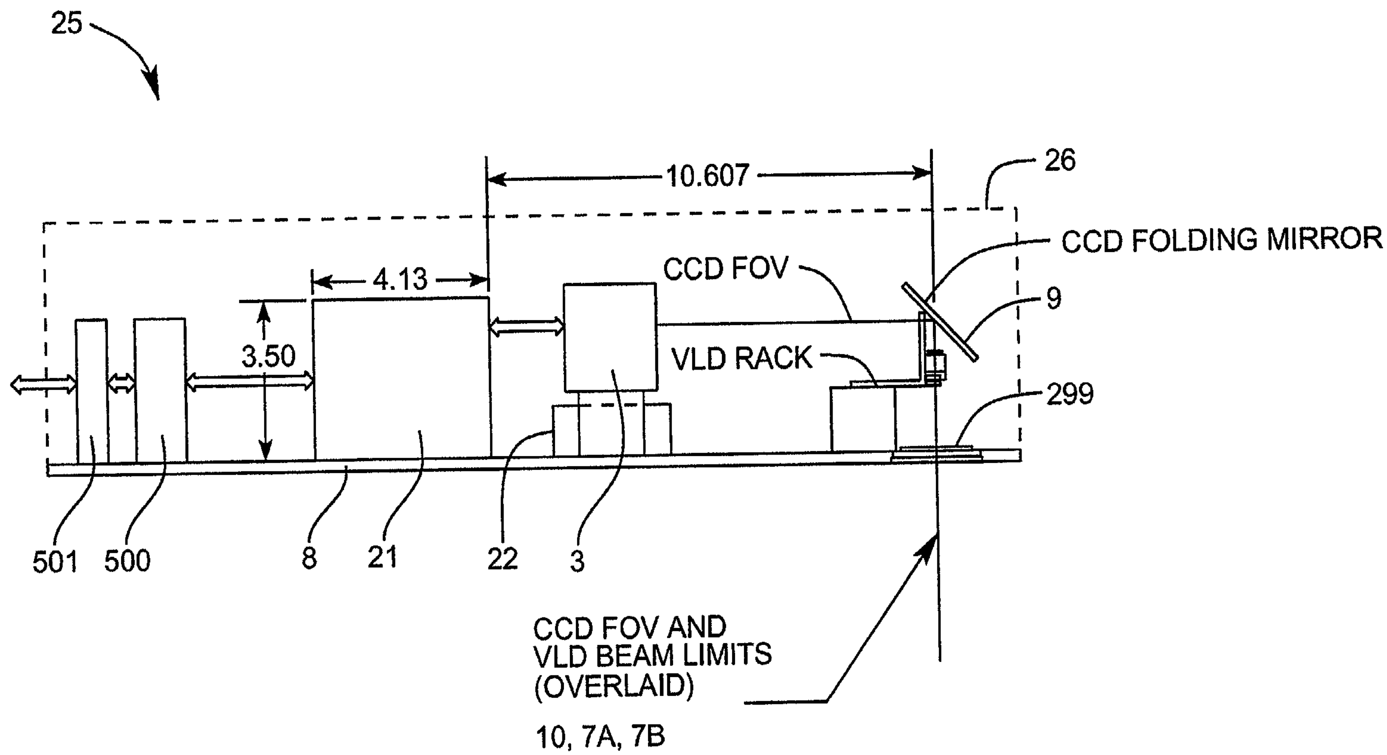

25
10.607
26
CCD FOLDING MIRROR
4.13
CCD FOV
9
3.50
VLD RACK
299
501
500
8
21
22
3
CCD FOV AND
VLD BEAM LIMITS
(OVERLAID)
10, 7A, 7B

FIG. 1G4

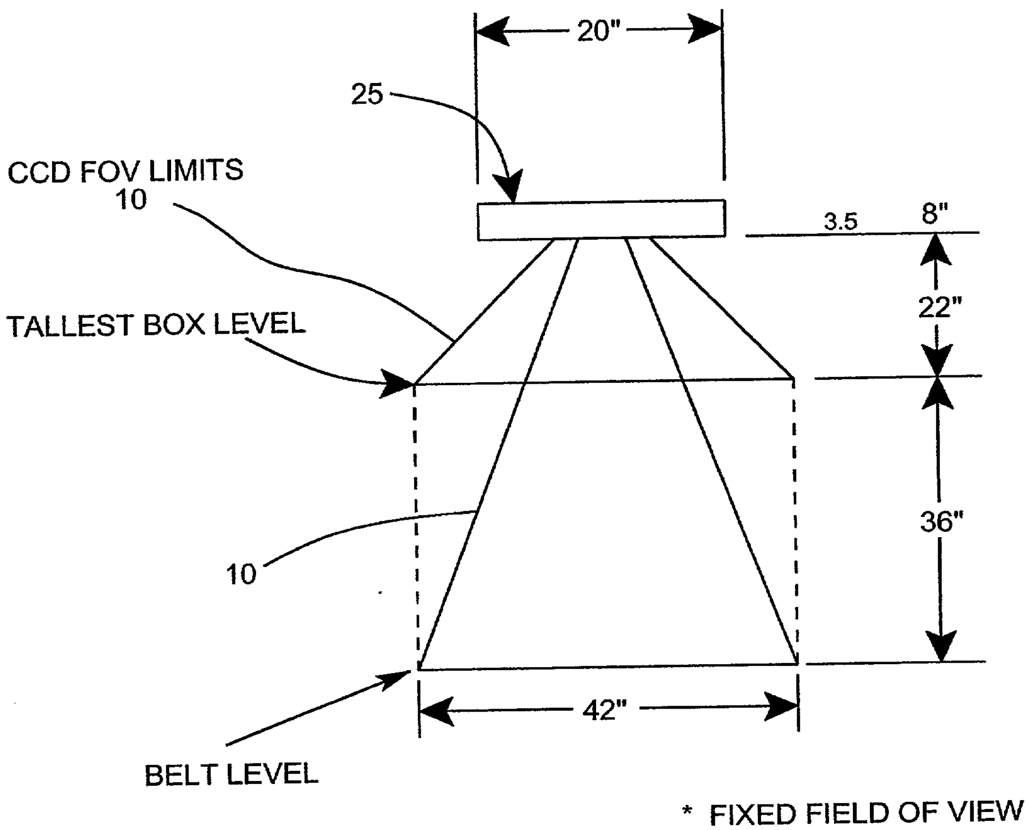

20"
25
CCD FOV LIMITS
10
3.5
8"
22"
TALLEST BOX LEVEL
36"
10
42"
BELT LEVEL
* FIXED FIELD OF VIEW

FIG. 1G5

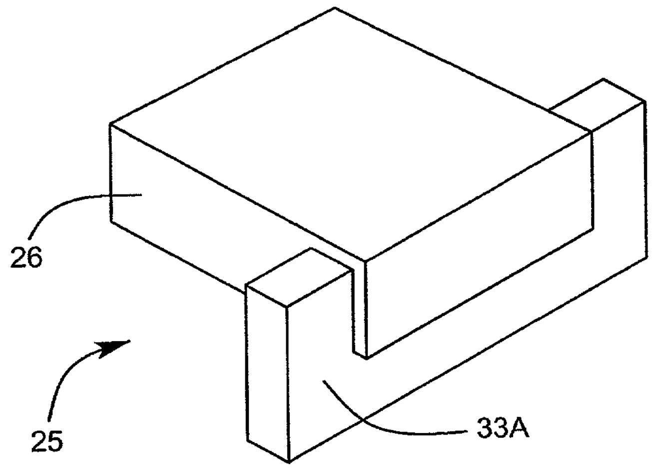


FIG. 1G6

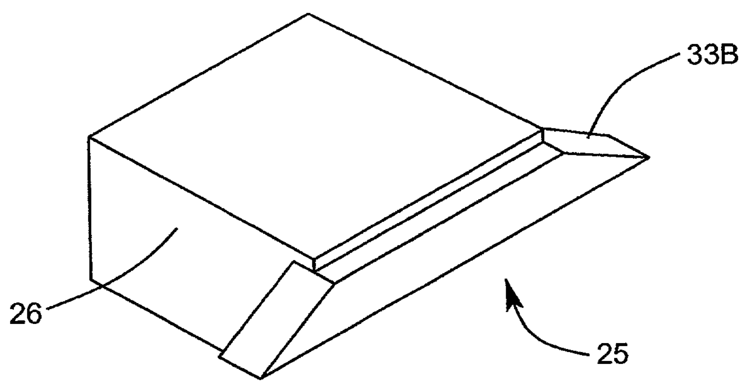


FIG. 1G7

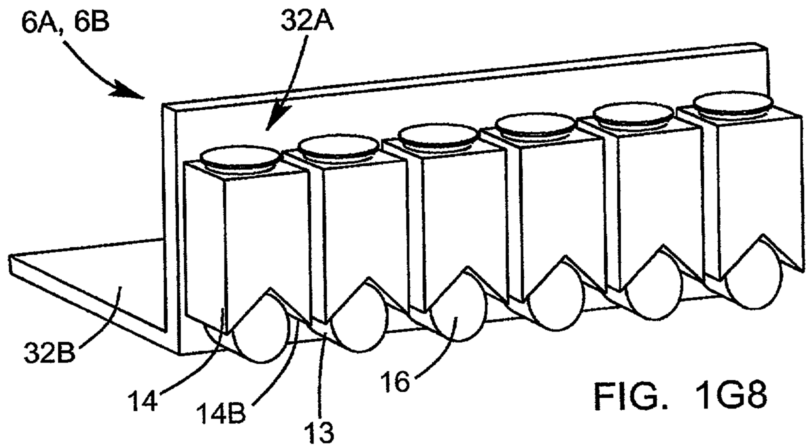


FIG. 1G8

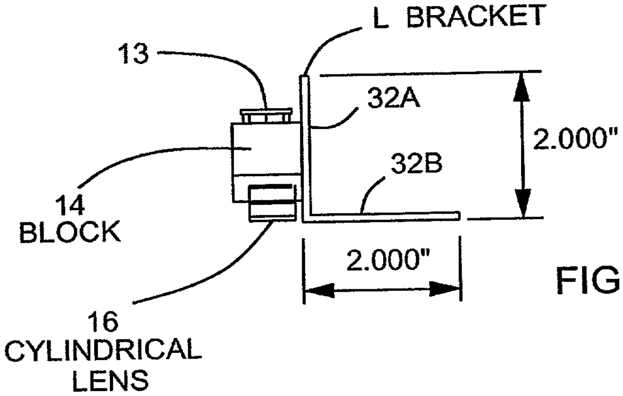


FIG. 1G9

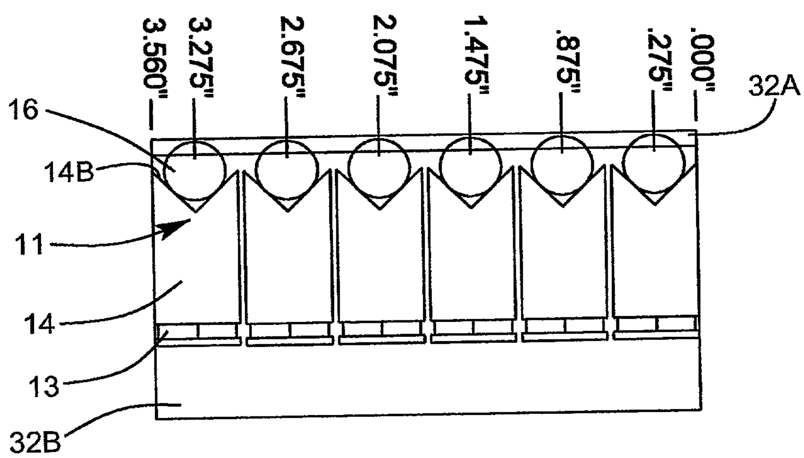


FIG. 1G10

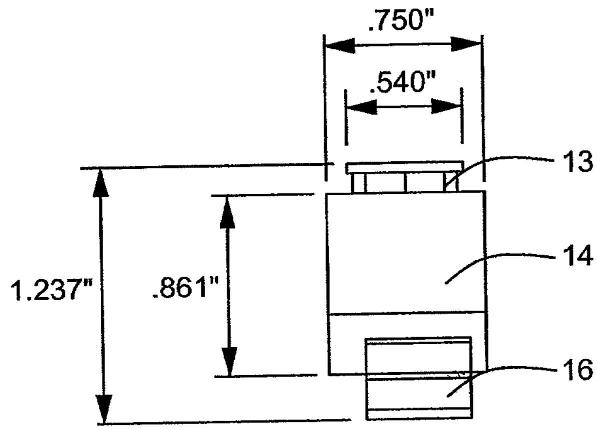


FIG. 1G11

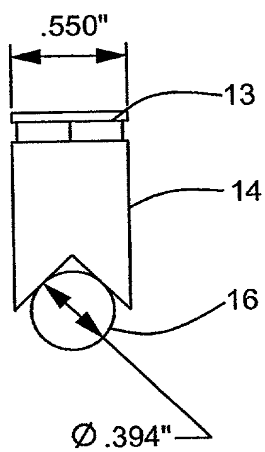


FIG. 1G12

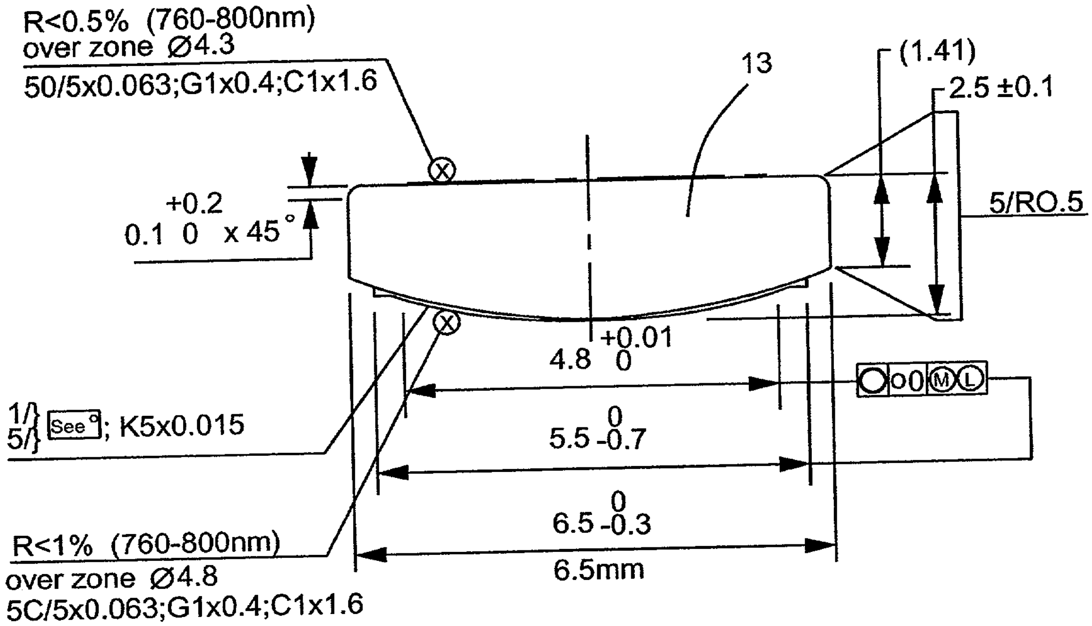


FIG. 1G13

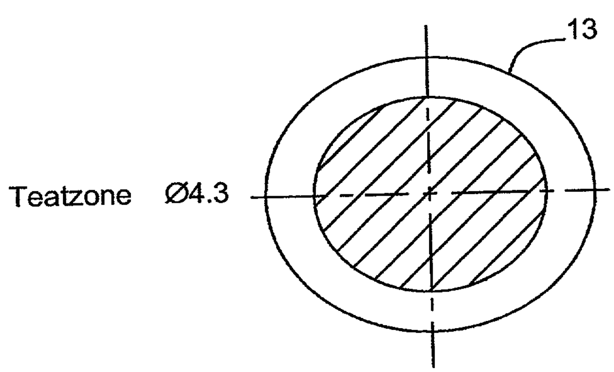


FIG. 1G14

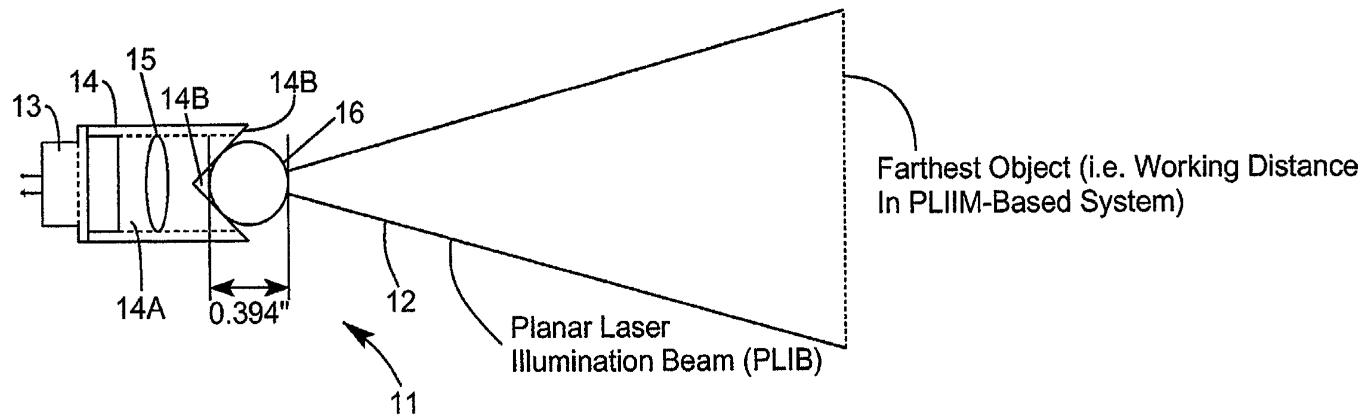


FIG. 1G15A

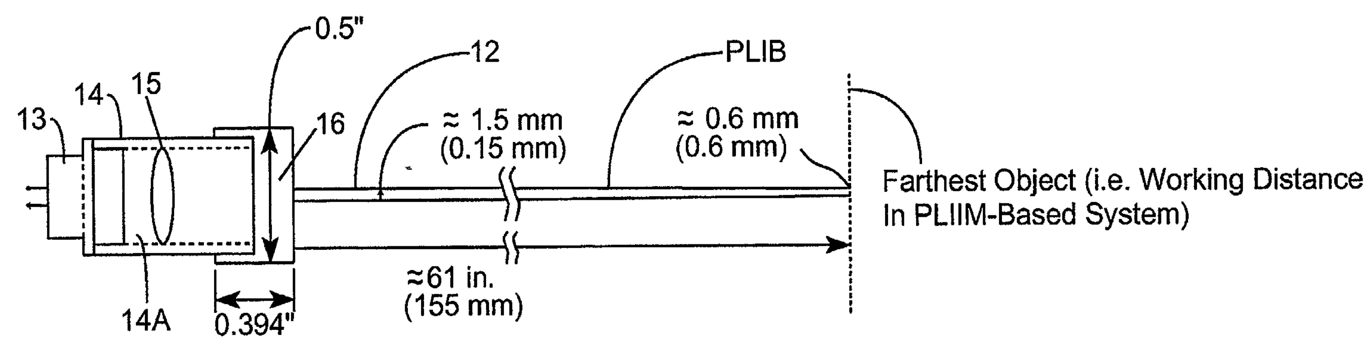


FIG. 1G15B

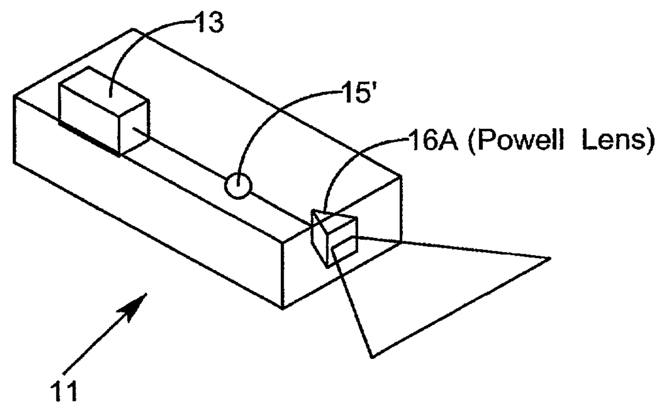


FIG. 1G16A

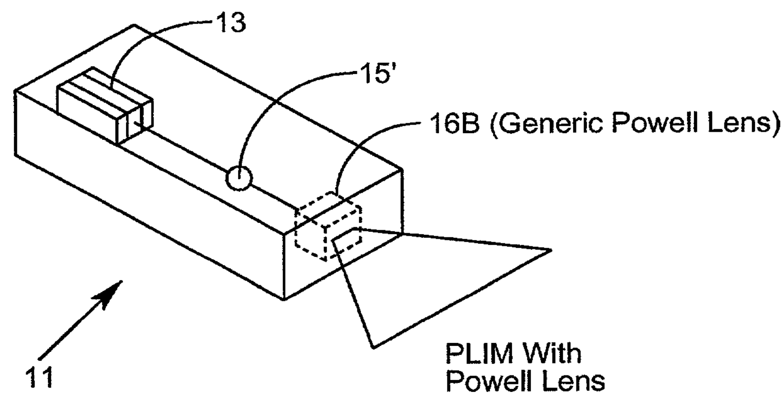


FIG. 1G16B

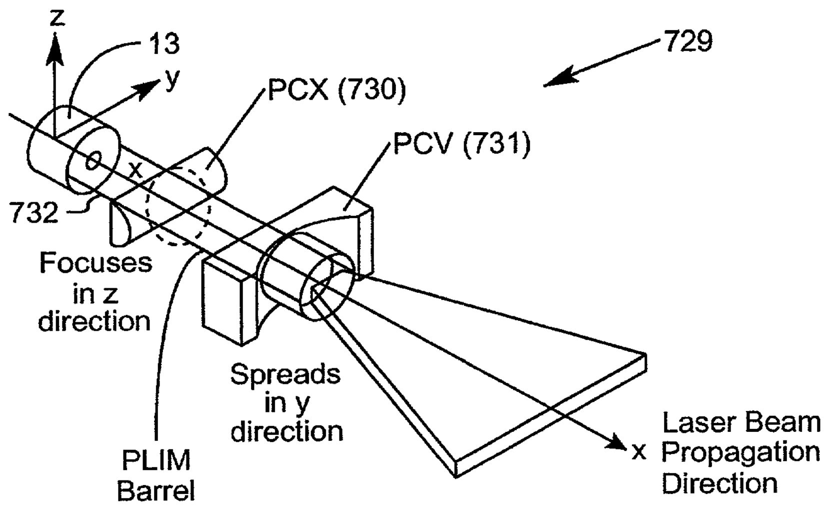


FIG. 1G17A

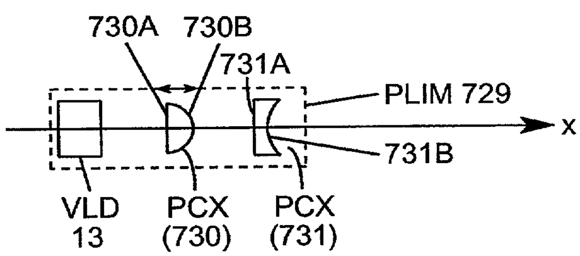


FIG. 1G17B

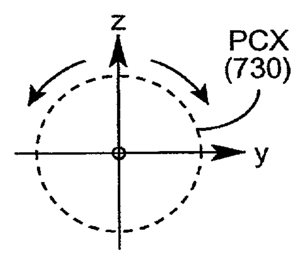


FIG. 1G17C

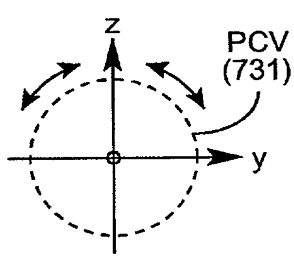


FIG. 1G17D

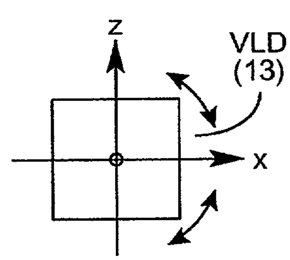


FIG. 1G17E

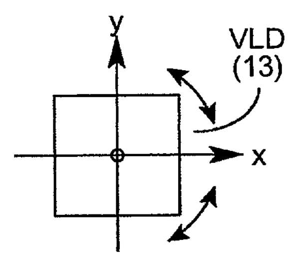
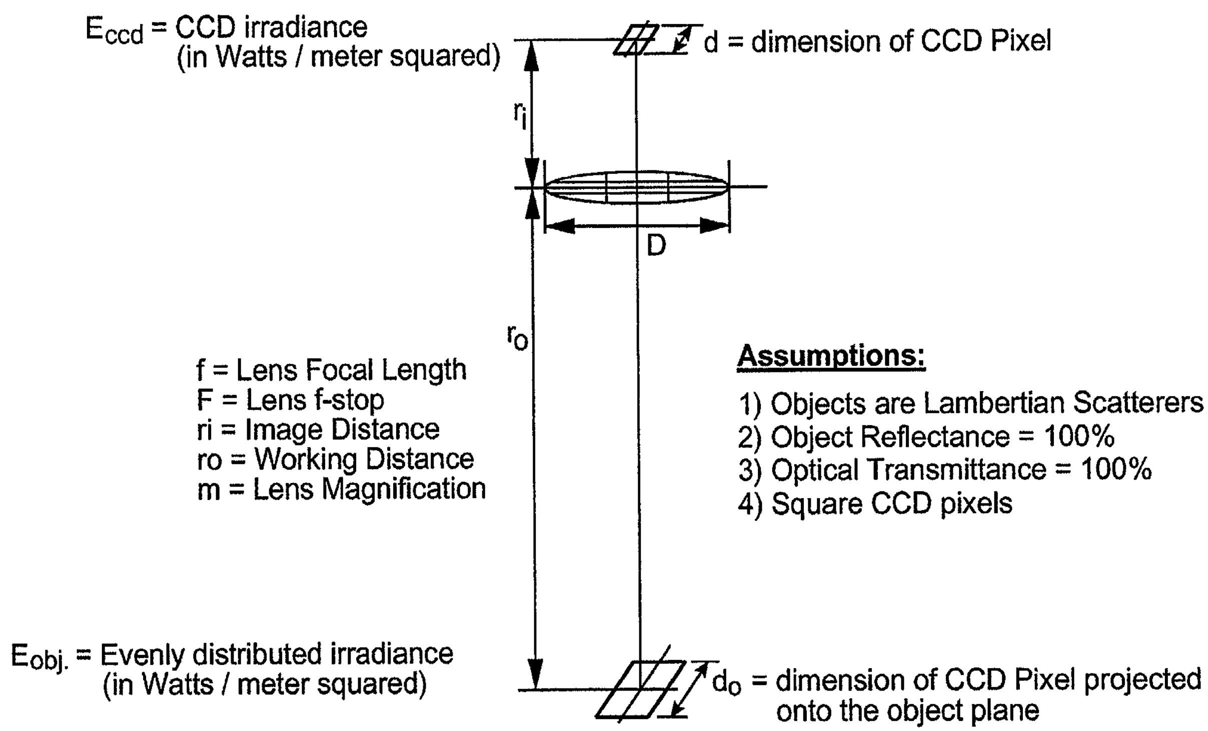


FIG. 1G17F



CCD-Based Scanner

FIG. 1H6

FIRST GENERALIZED METHOD OF REDUCING SPECKLE-NOISE PATTERNS AT IMAGE DETECTION ARRAY OF THE IFD SUBSYSTEM (3)

(SPMF)

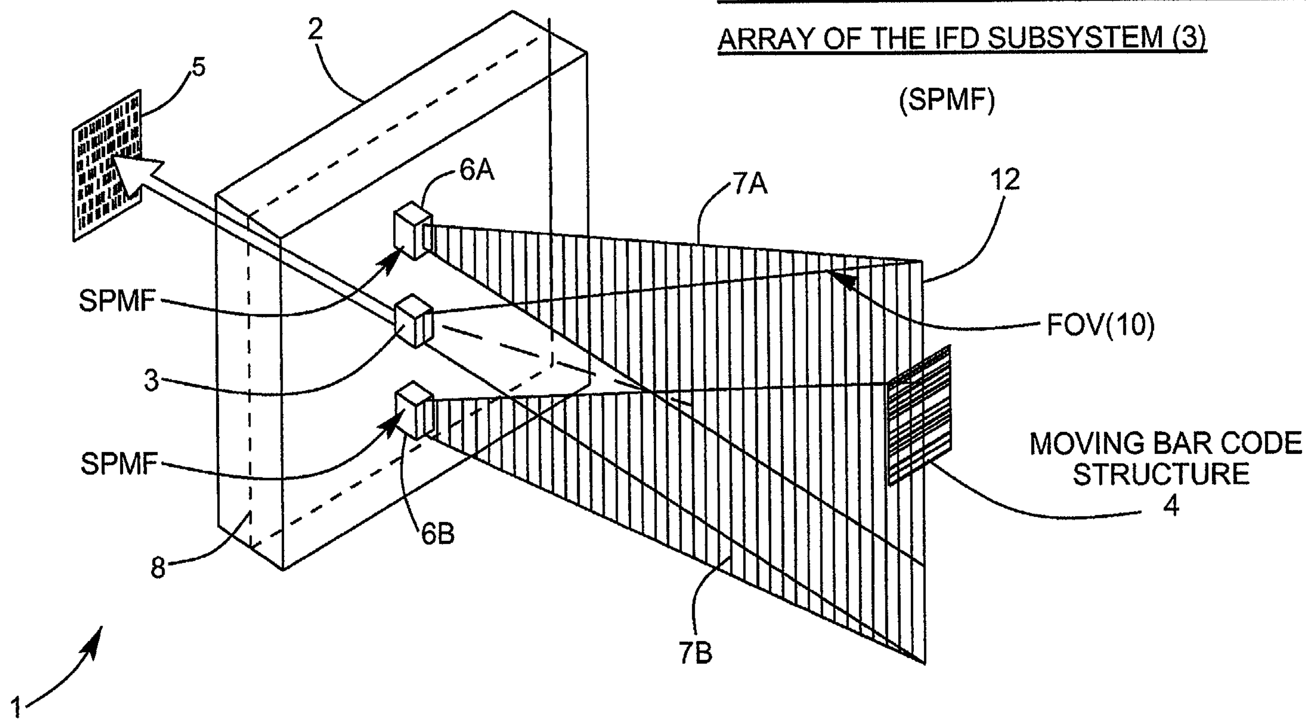
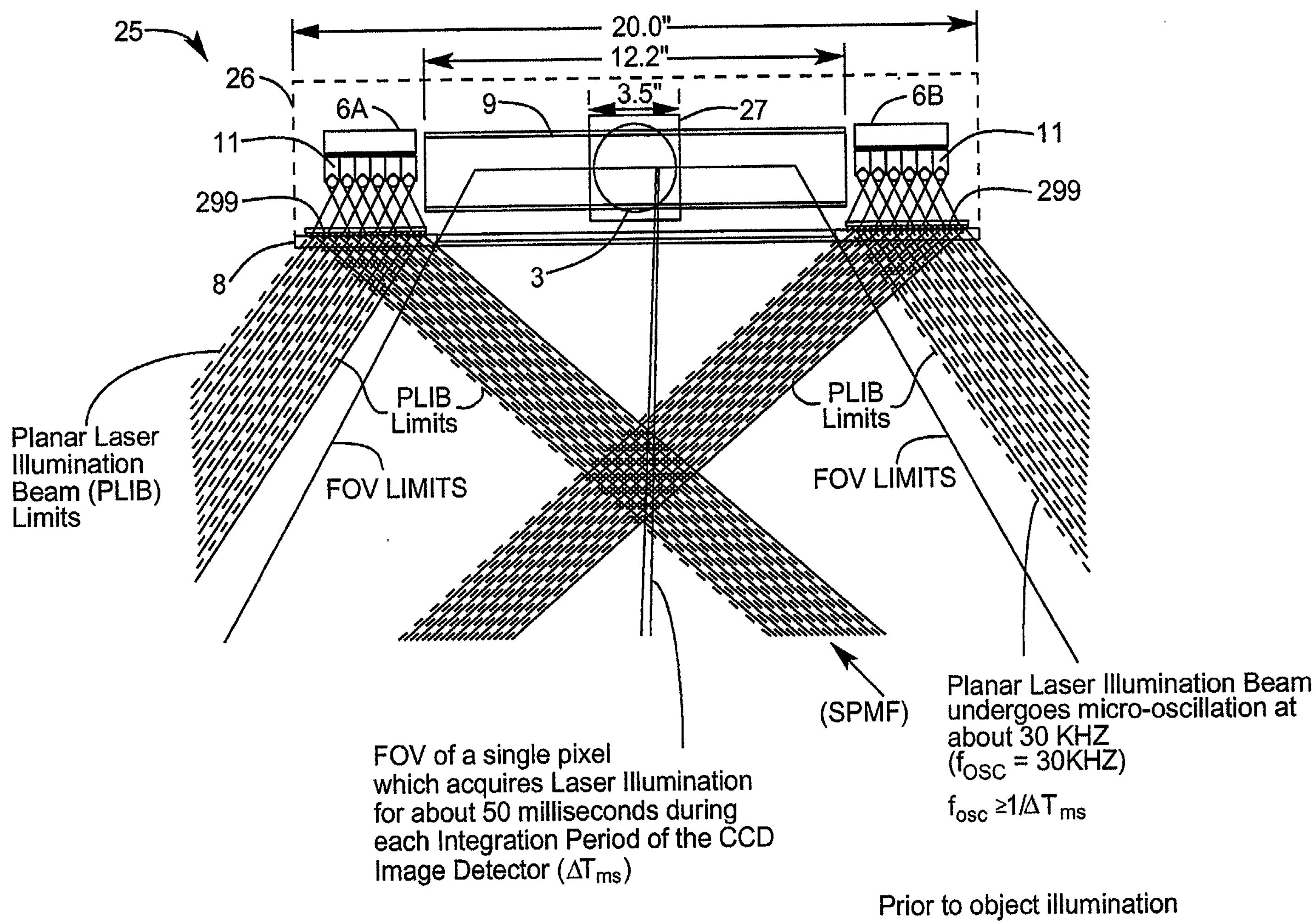


FIG. 1I1



25
26
20.0"
12.2"
3.5"
6A
6B
9
27
11
11
299
299
8
3
Planar Laser Illumination Beam (PLIB) Limits
PLIB Limits
PLIB Limits
FOV LIMITS
FOV LIMITS
(SPMF)
FOV of a single pixel which acquires Laser Illumination for about 50 milliseconds during each Integration Period of the CCD Image Detector (ΔT_{ms})
Planar Laser Illumination Beam undergoes micro-oscillation at about 30 KHZ (f_{OSC} = 30KHZ)
$f_{osc} \geq 1/\Delta T_{ms}$
Prior to object illumination

FIG. 1I2A

THE FIRST GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the spatial phase of the transmitted PLIB along the planar extent thereof according to a spatial phase modulation function (SPMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

A

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the power of the speckle-noise pattern observed at the image detection array.

B

FIG. 1I2B

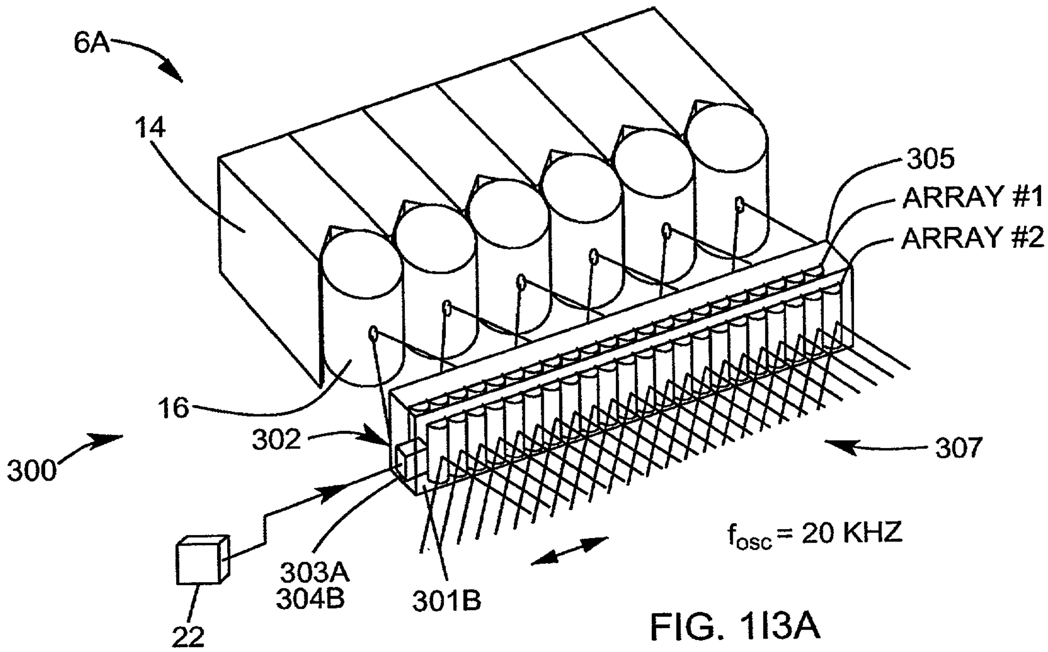


FIG. 1I3A

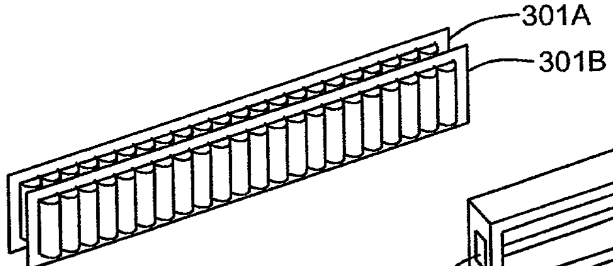


FIG. 1I3B

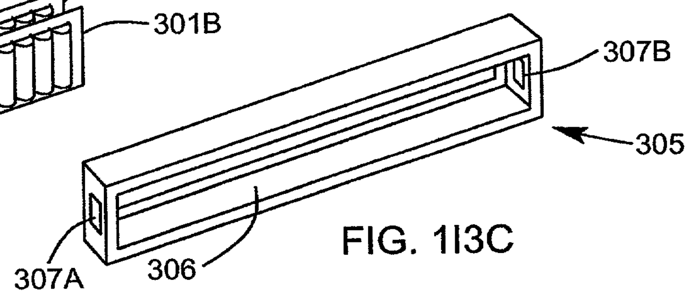


FIG. 1I3C

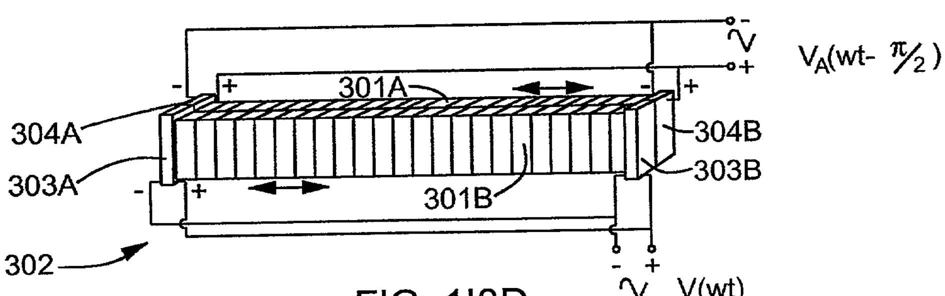
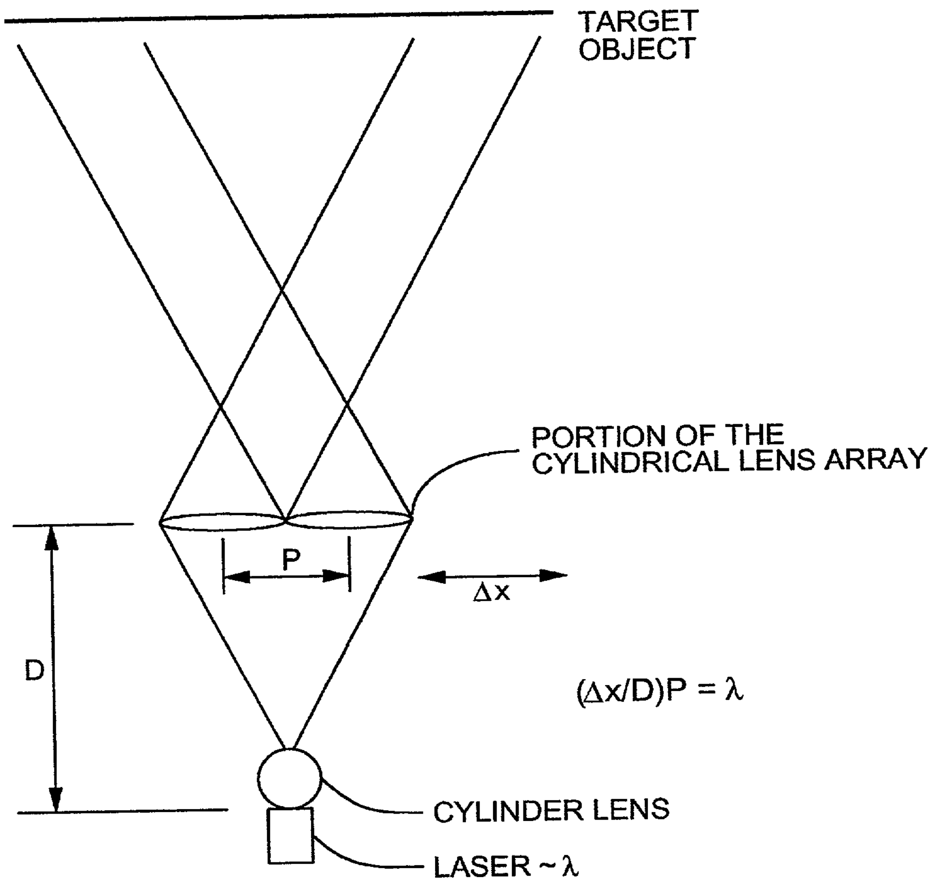


FIG. 1I3D



$$\boxed{\Delta x \geq \frac{\lambda}{P} \cdot D}$$

FIG. 1I3E

FIG. 113F

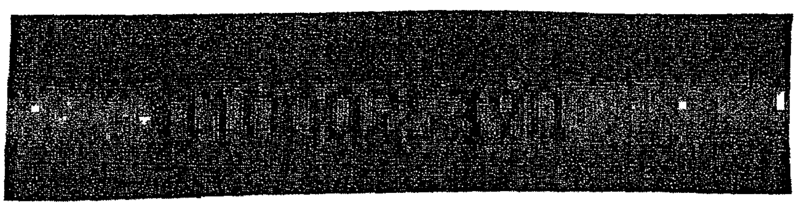


FIG. 113G

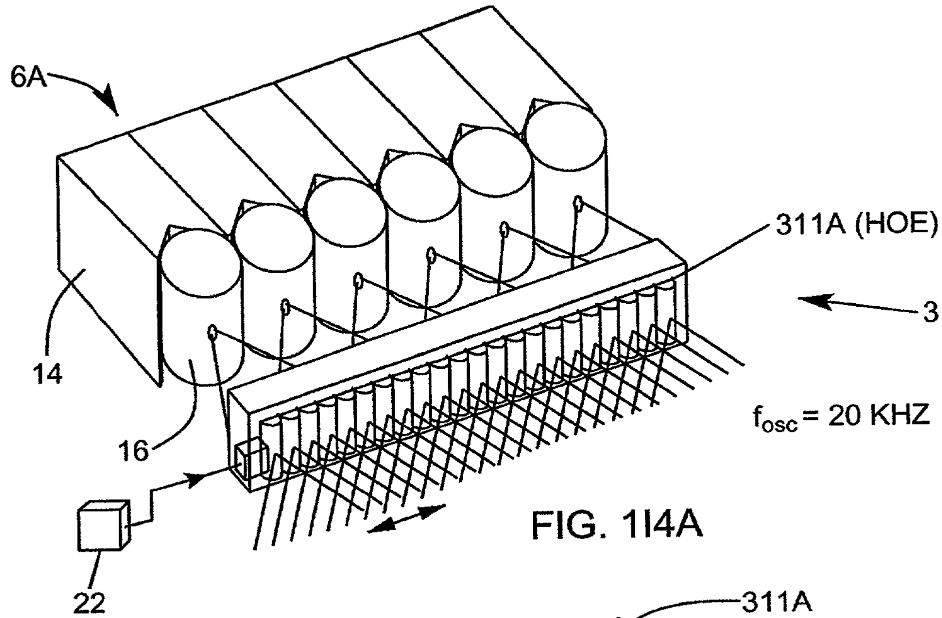


FIG. 114A

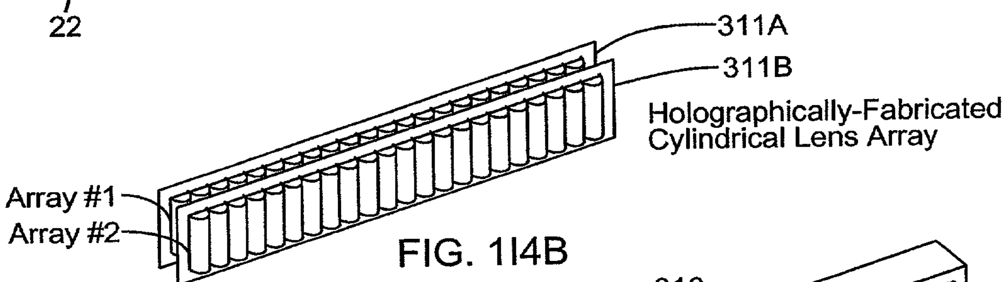


FIG. 114B

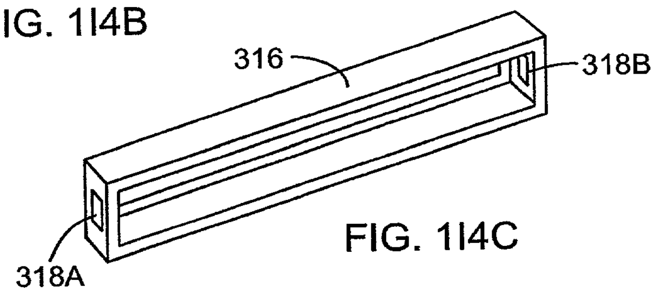


FIG. 114C

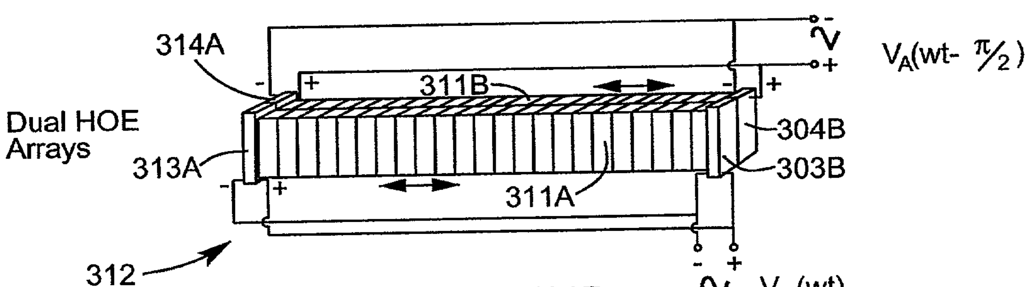


FIG. 114D

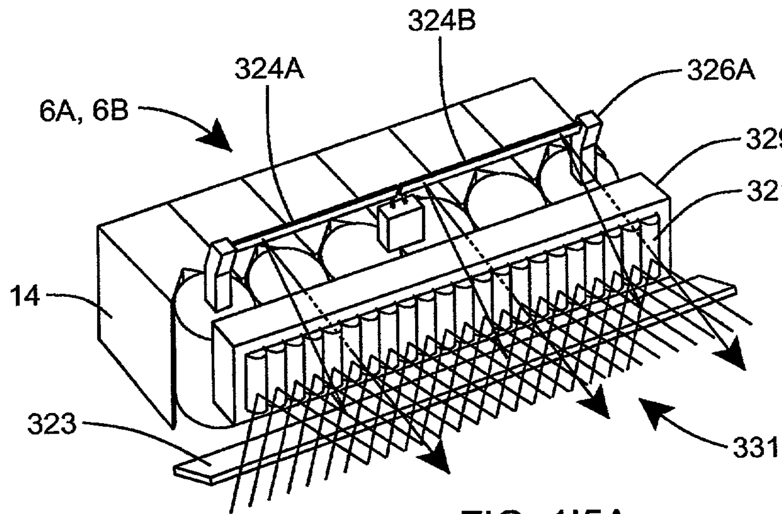


FIG. 1I5A

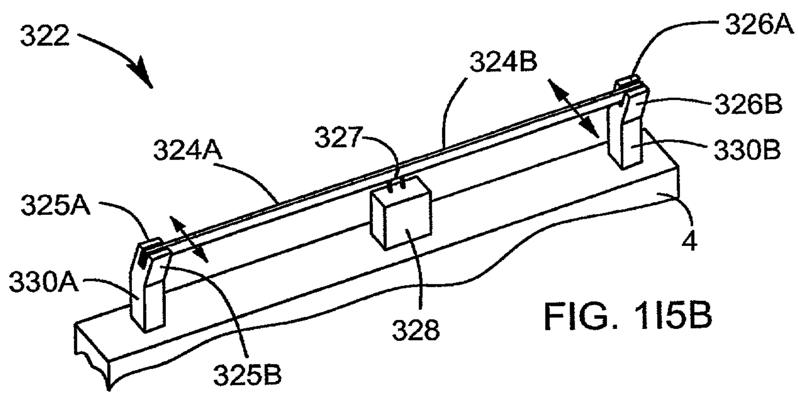


FIG. 1I5B

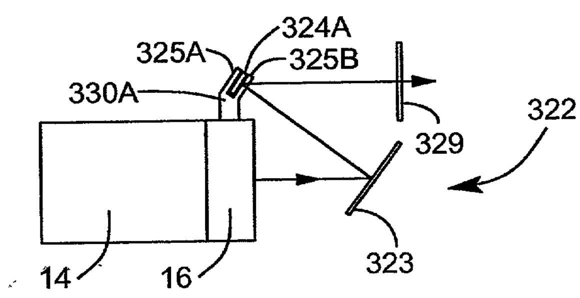


FIG. 1I5C

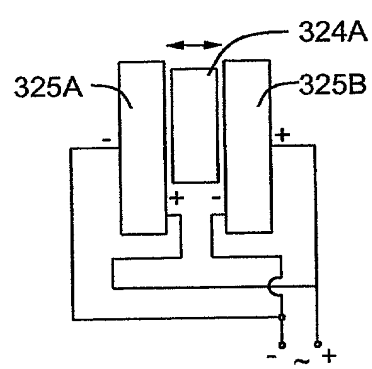


FIG. 1I5D

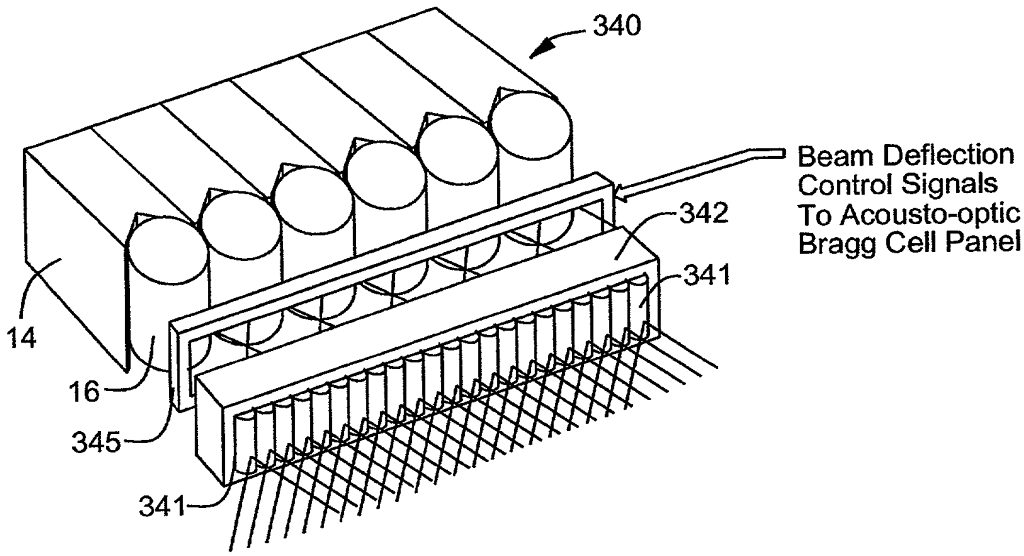


FIG. 116A

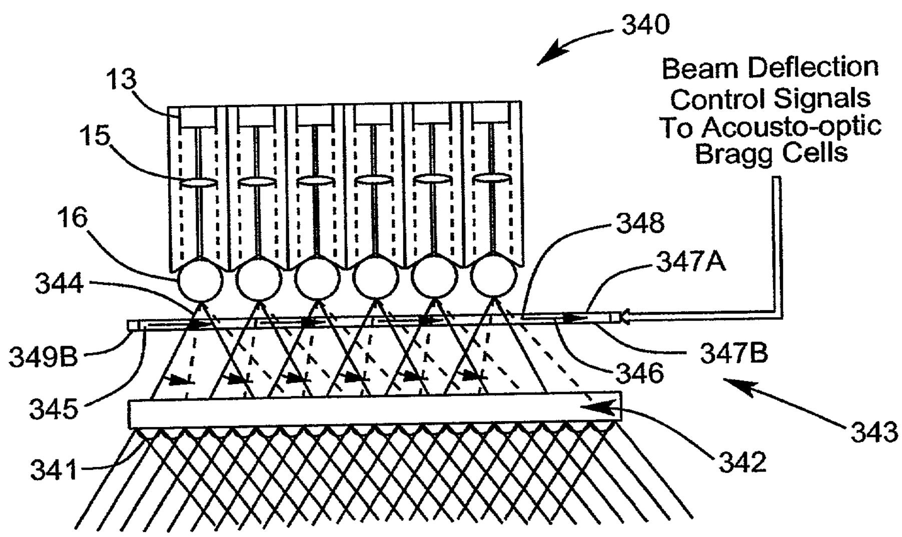


FIG. 116B

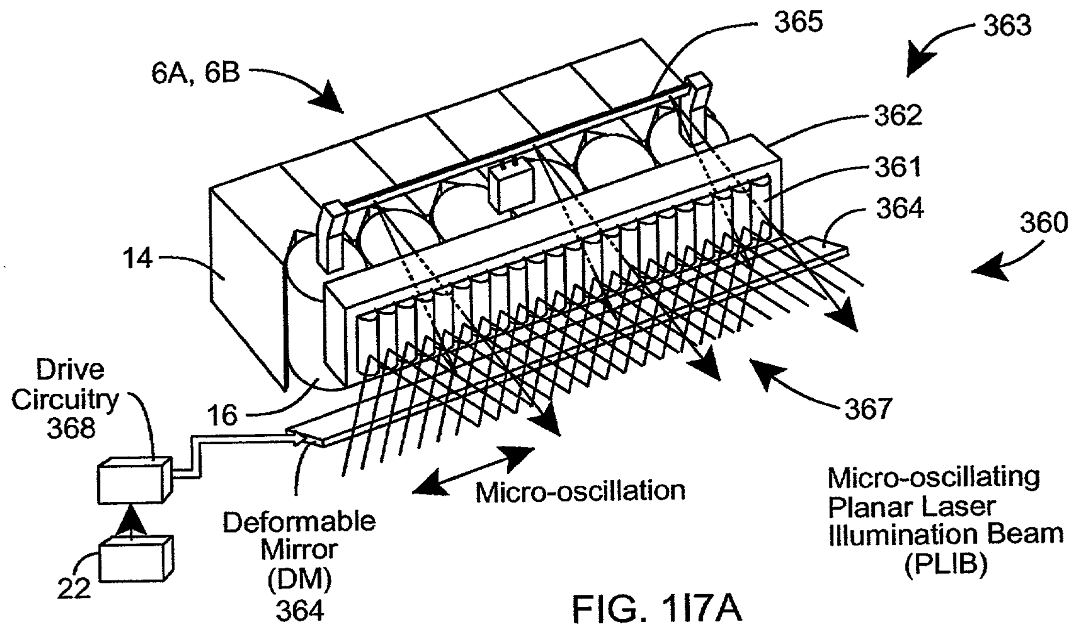


FIG. 1I7A

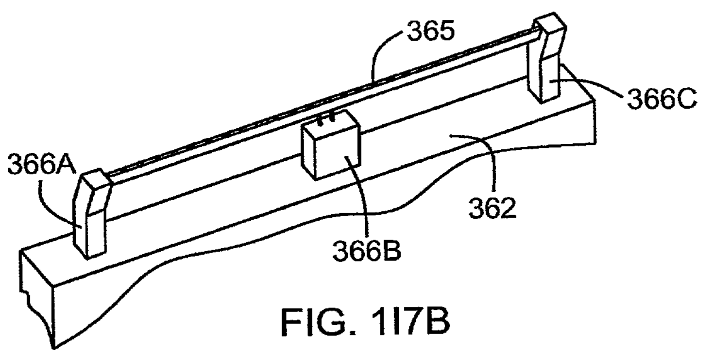


FIG. 1I7B

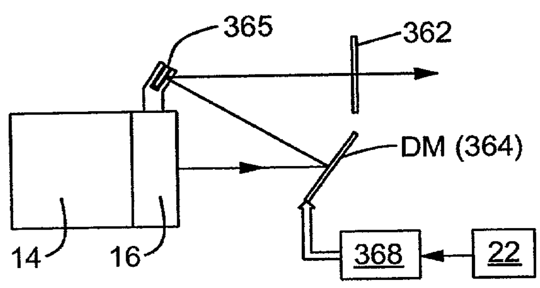


FIG. 1I7C

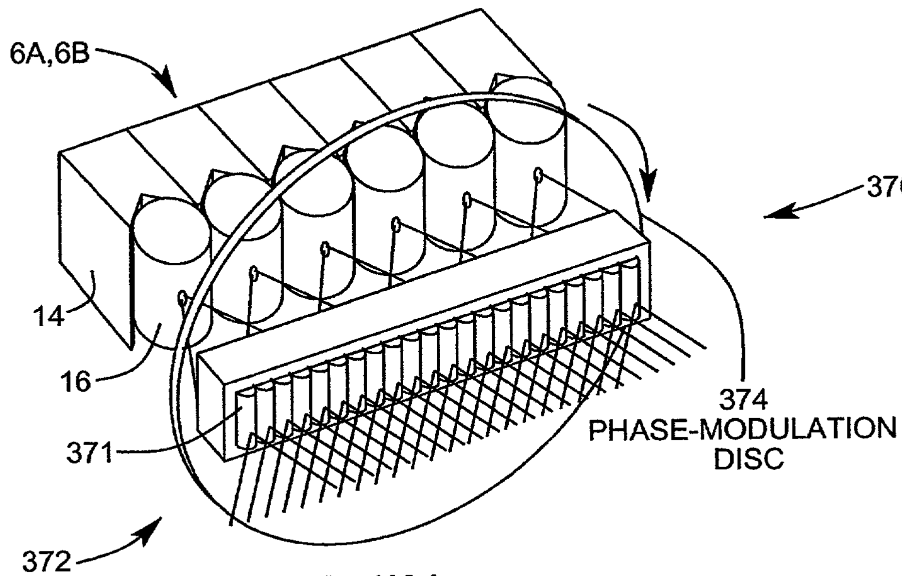


FIG. 1I8A

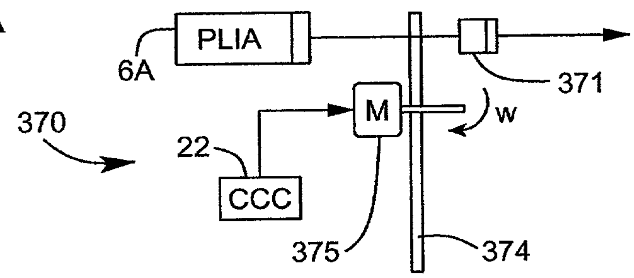


FIG. 1I8B

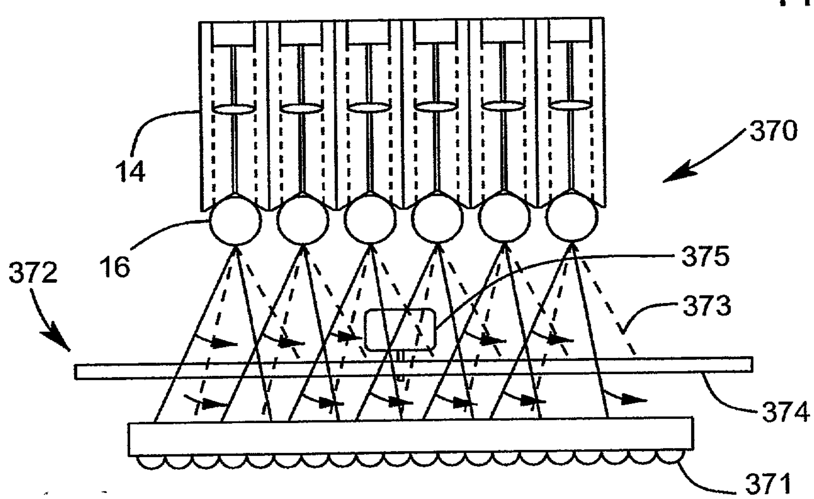


FIG. 1I8C

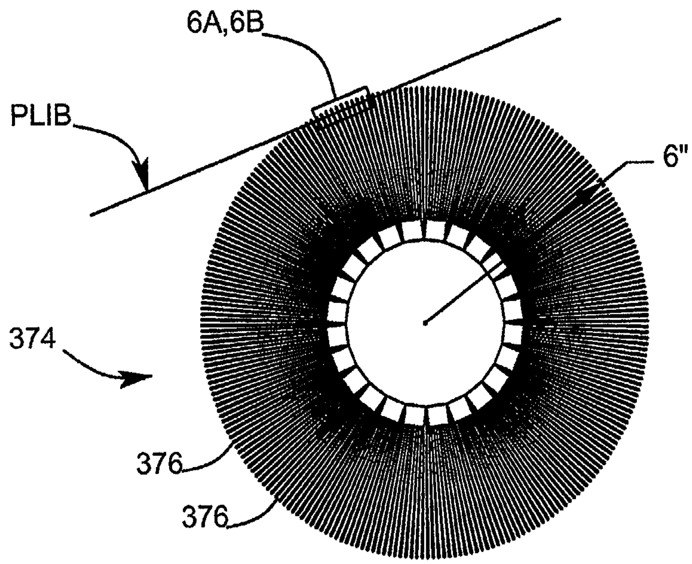


FIG. 1I8D

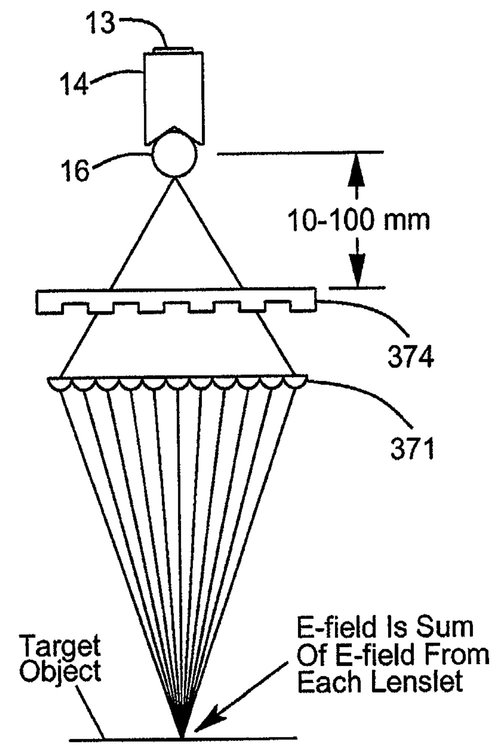


FIG. 1I8E

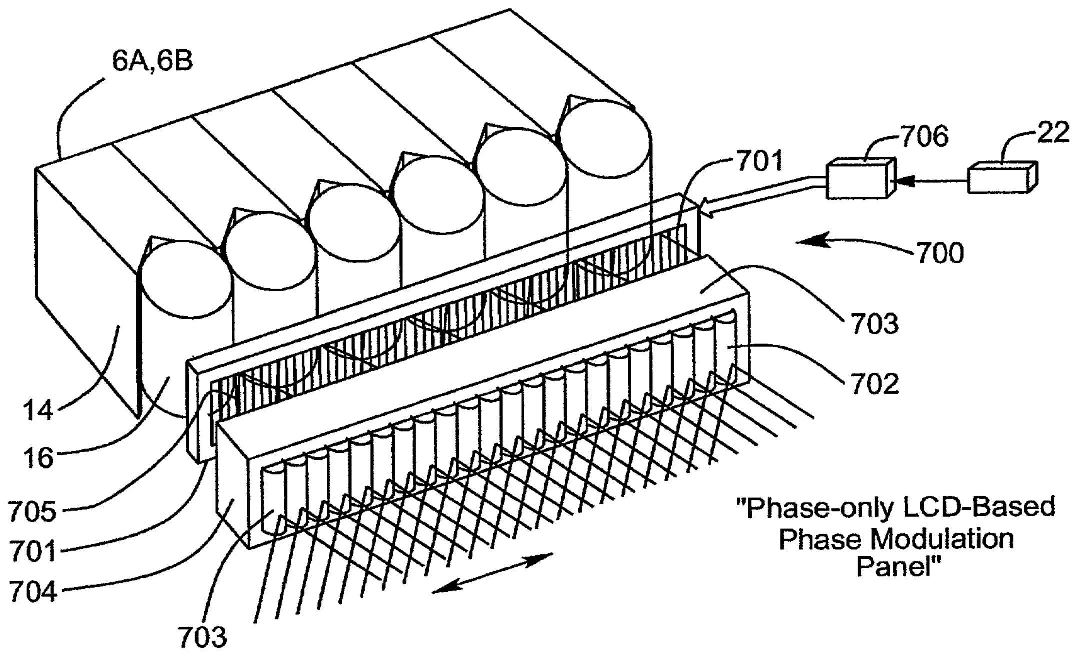


FIG. 1I8F

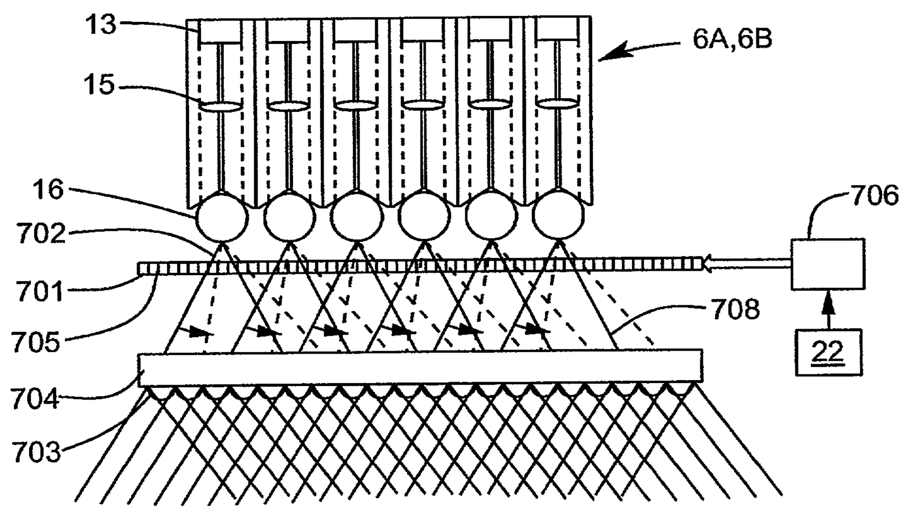


FIG. 1I8G

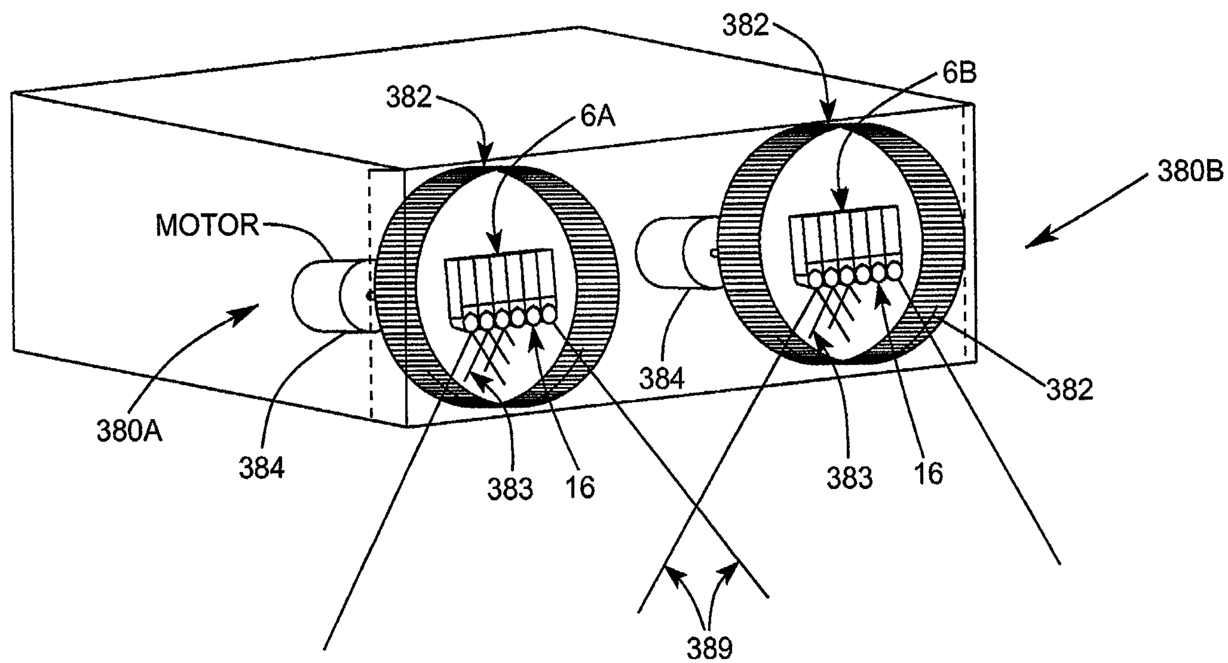
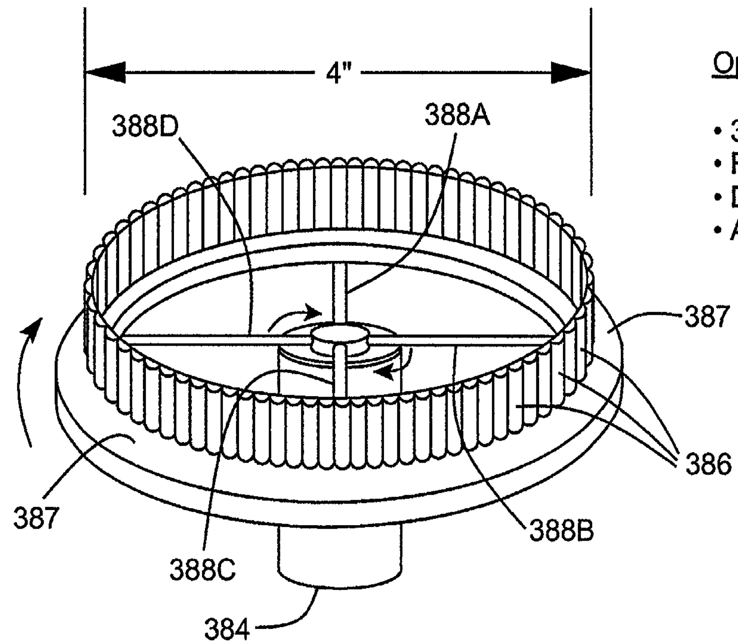


FIG. 1I9A



<u>Optical Specifications:</u>

- 30 Cylindrical Lens (Lines) Per Linear Inch
- Focal Length ≈ 20 Millimeters
- Diameter Of Lenticular Carousel ≈ 4 Inches
- Acrylic Material

FIG. 1I9B

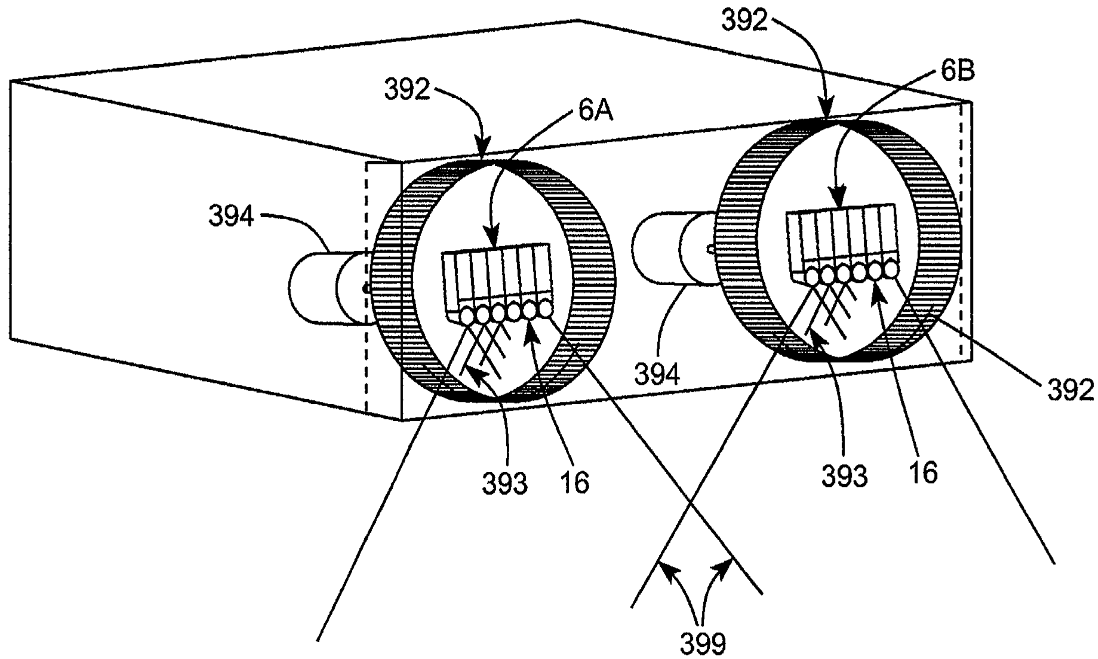
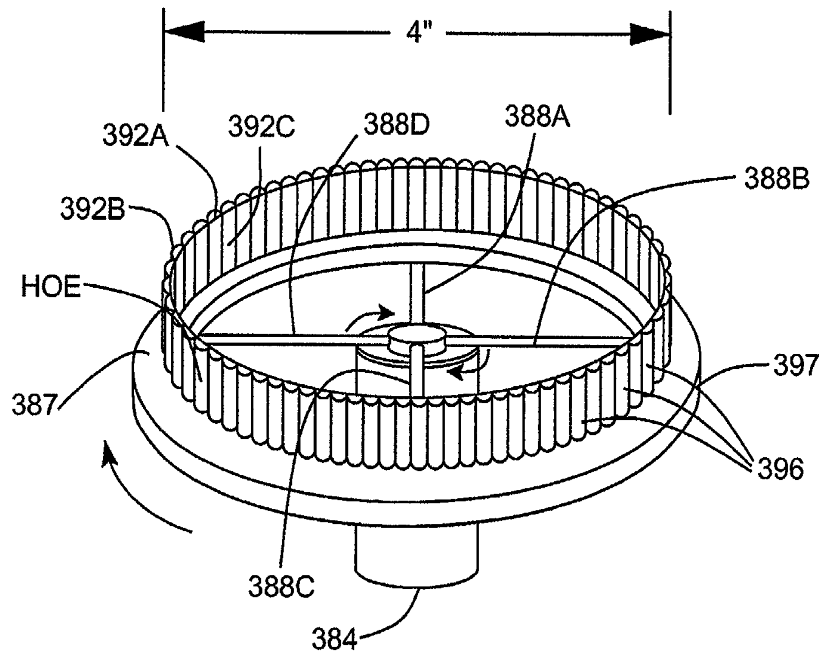


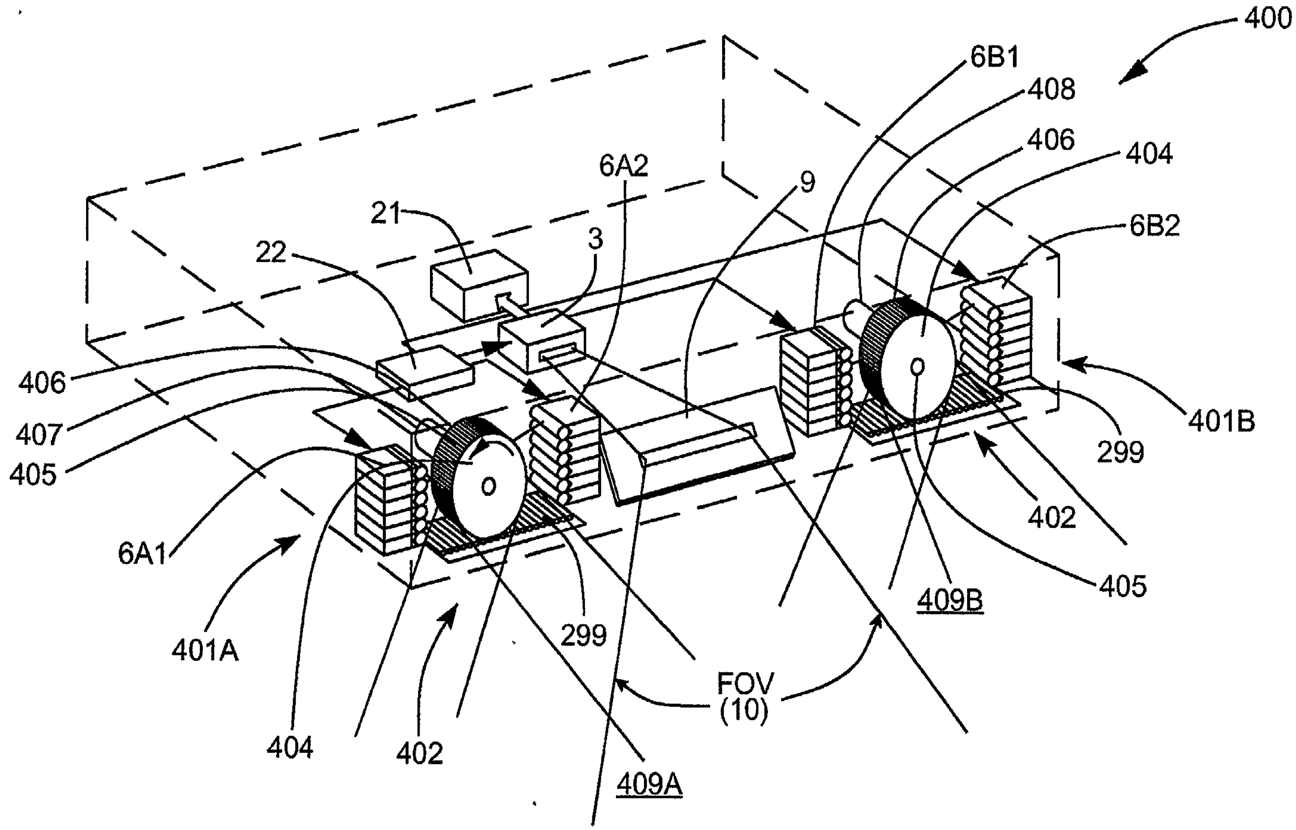
FIG. 1I10A



Optical Specifications:

- 30 Cylindrical Lens (Lines) Per Linear Inch
- Focal Length ≈ 20 Millimeters
- Diameter Of Lenticular Carousel ≈ 4 Inches

FIG. 1I10B



400
6B1
408
406
404
6B2
6A2
9
21
3
22
406
407
405
6A1
401A
404
402
299
409A
FOV
(10)
409B
405
402
299
401B

FIG. 1I11A

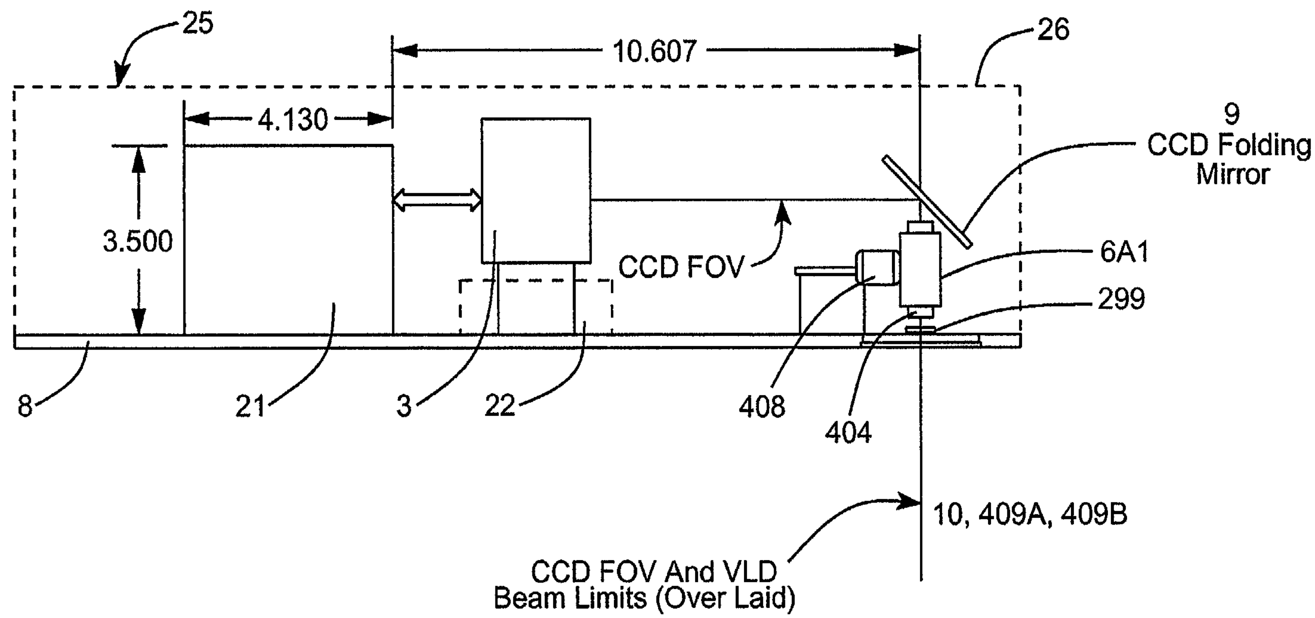

25
26
10.607
4.130
3.500
9
CCD Folding
Mirror
CCD FOV
6A1
299
8
21
3
22
408
404
10, 409A, 409B
CCD FOV And VLD
Beam Limits (Over Laid)

FIG. 1I11B

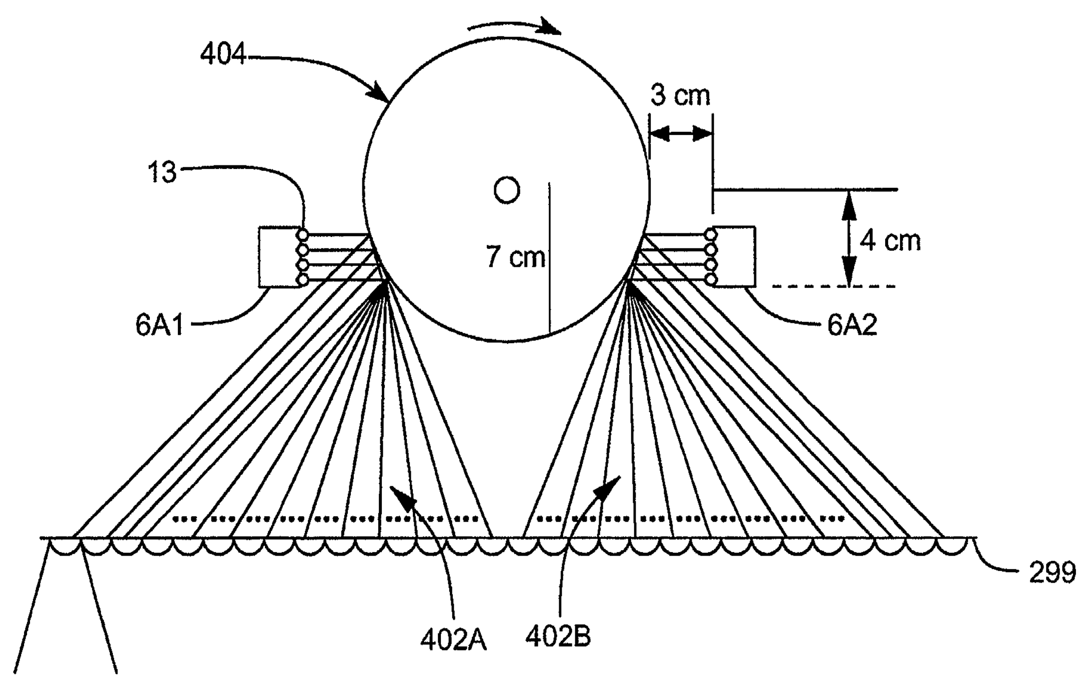


FIG. 1I11C

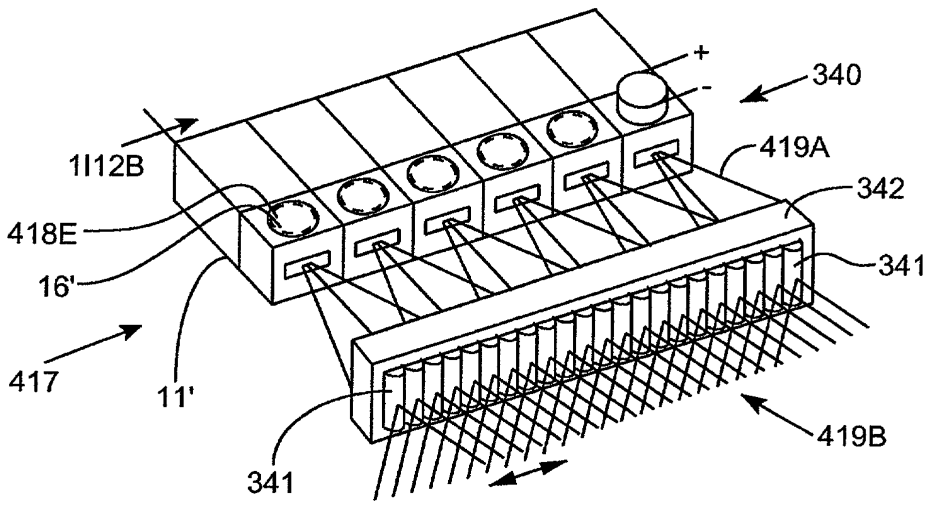


FIG. 1I12A

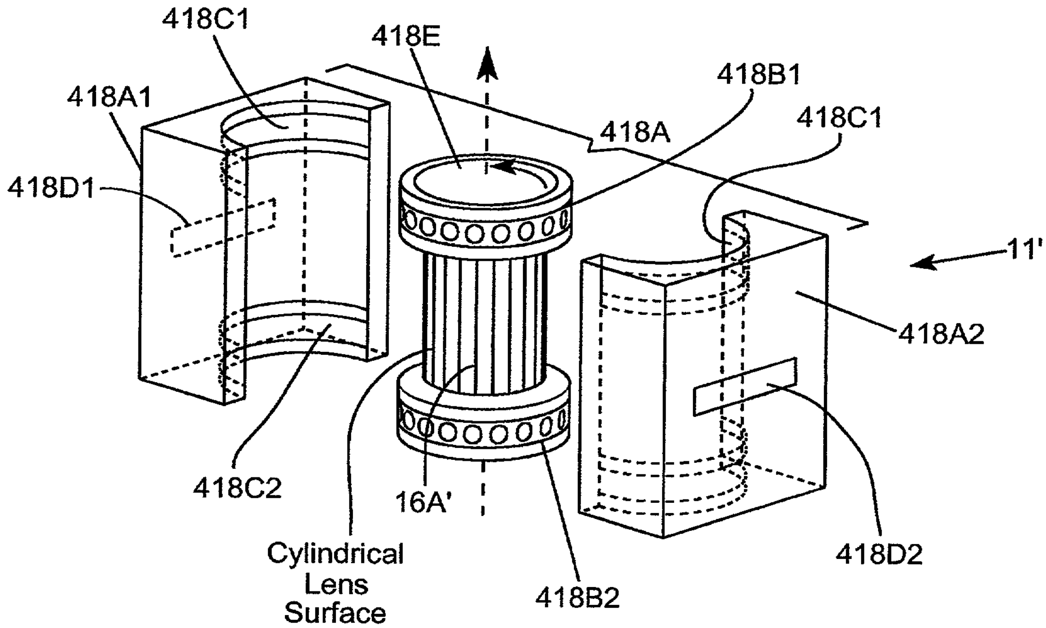


FIG. 1I12B

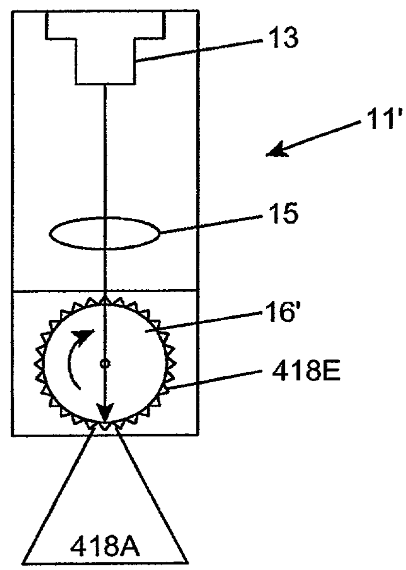


FIG. 1I12C

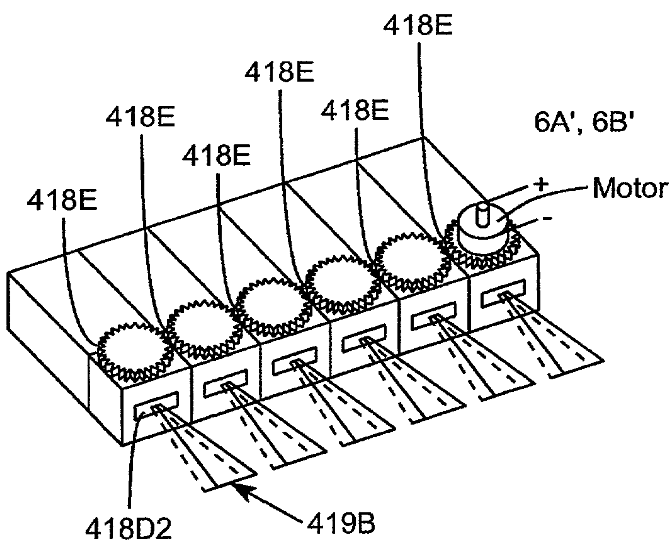


FIG. 1I12D

Second Generalized Method Of Reducing Speckle-Noise Patterns At Image Detection Array Of The IFD Subsystem (3)

(TIMF)

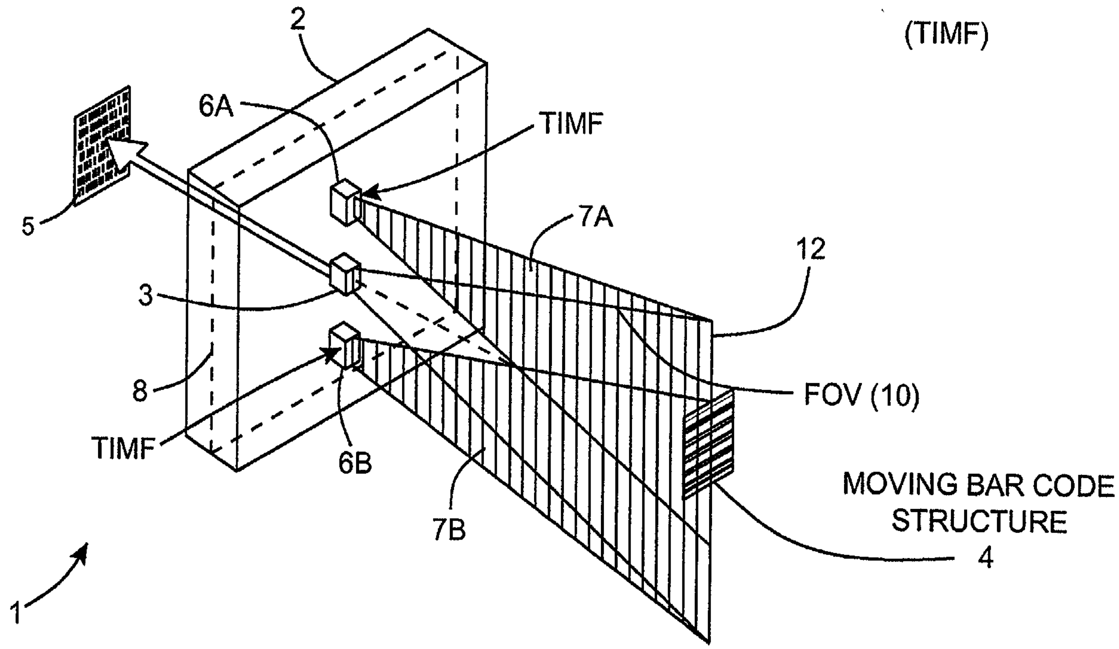


FIG. 1I13

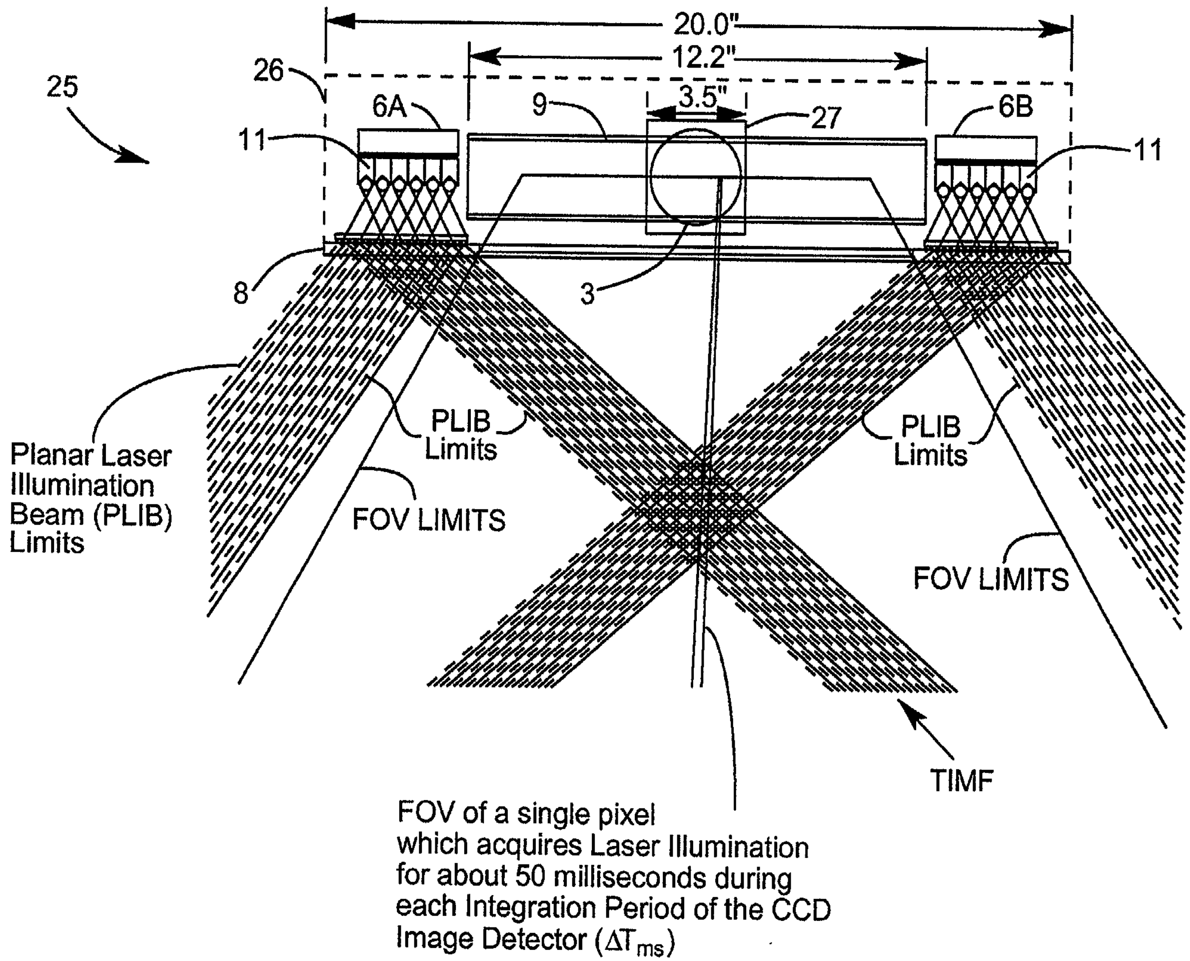

20.0"
12.2"
3.5"
25
26
6A
9
27
6B
11
11
8
3
Planar Laser Illumination Beam (PLIB) Limits
PLIB Limits
PLIB Limits
FOV LIMITS
FOV LIMITS
TIMF
FOV of a single pixel which acquires Laser Illumination for about 50 milliseconds during each Integration Period of the CCD Image Detector (ΔT_{ms})

FIG. 1I13A

THE SECOND GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal intensity of the transmitted PLIB along the planar extent thereof according to a temporal intensity modulation function (TIMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof. A

↓

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the power of the speckle-noise pattern observed at the image detection array. B

FIG. 1I13B

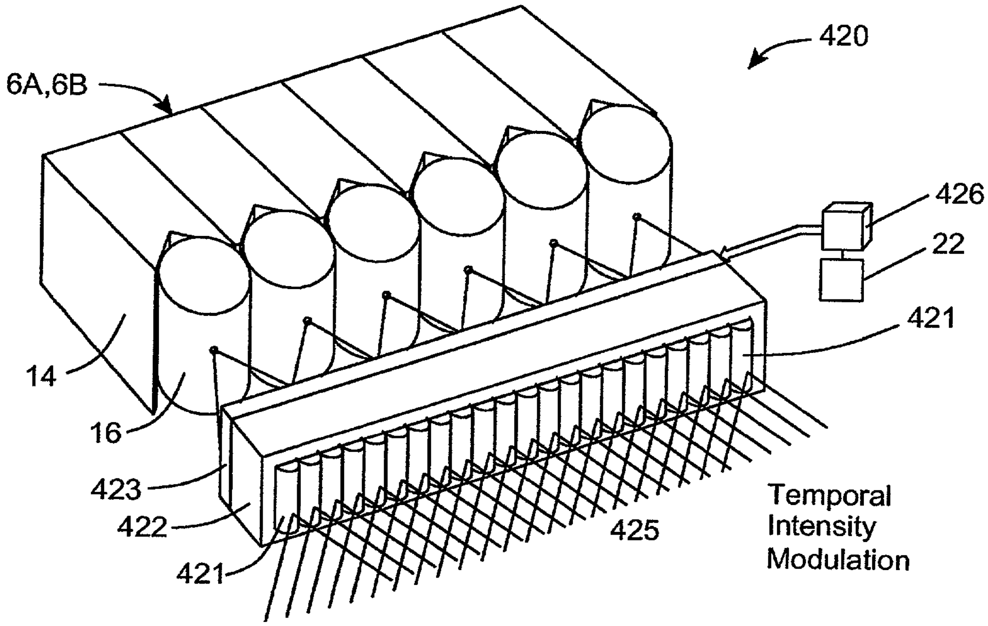


FIG. 1I14A

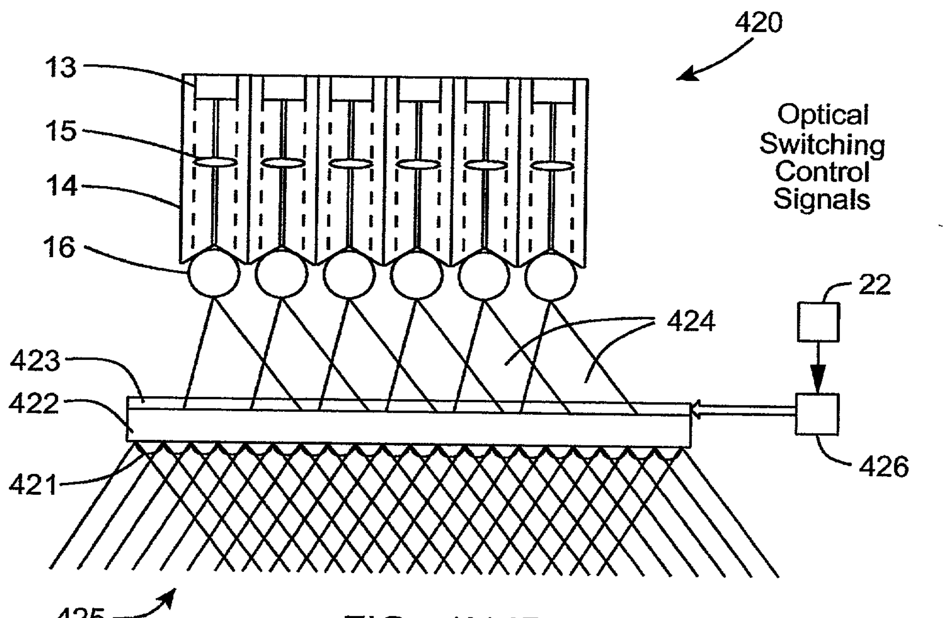


FIG. 1I14B

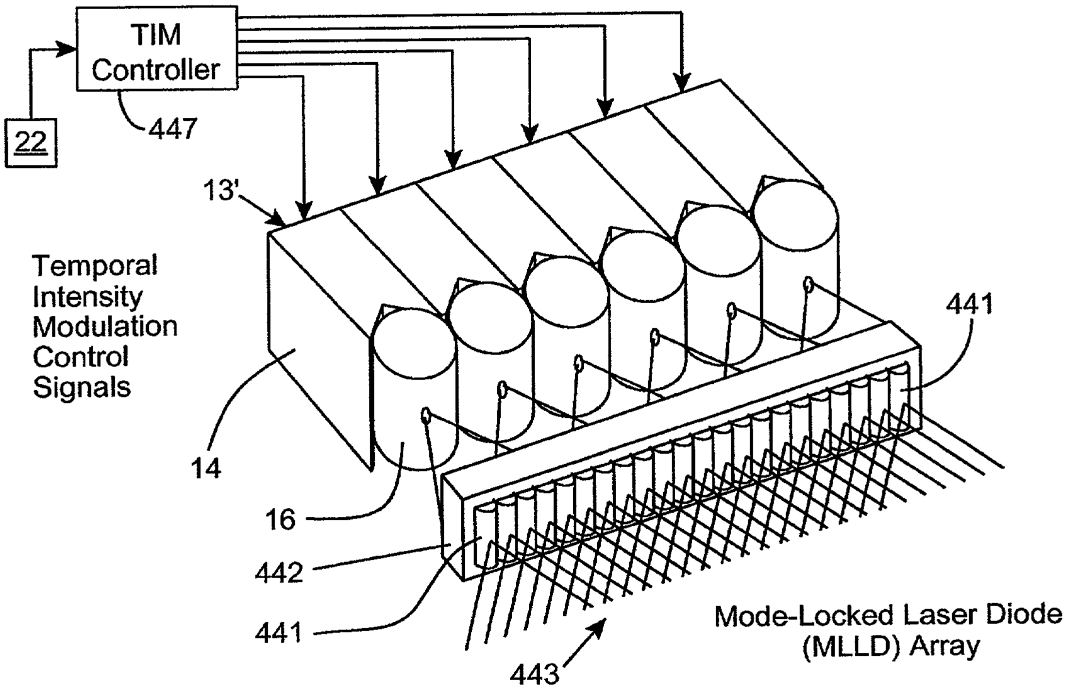


FIG. 1I15A

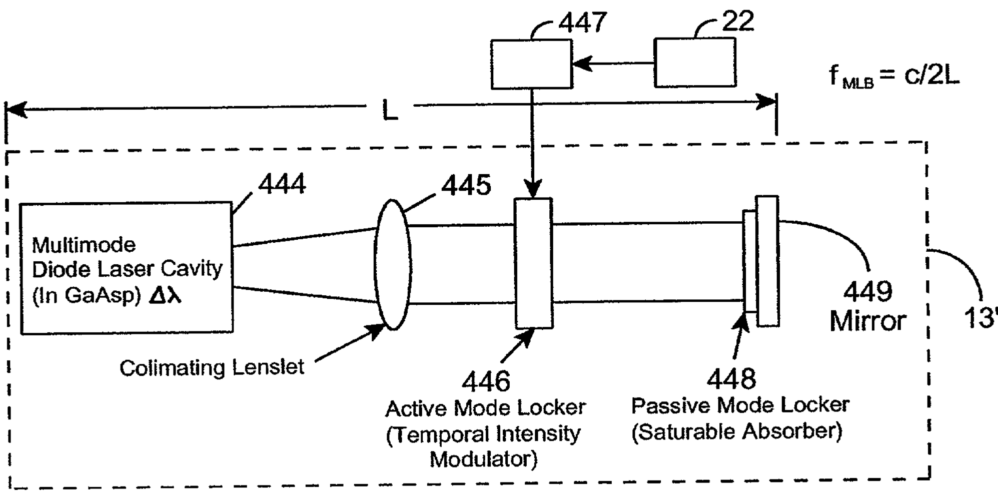


FIG. 1I15B

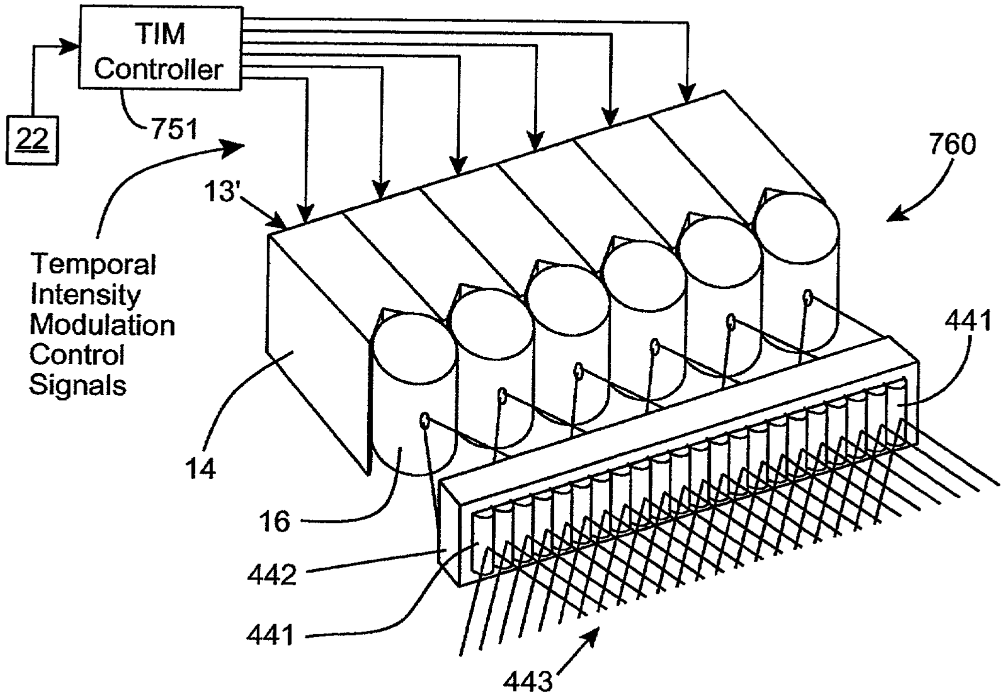


FIG. 1I15C

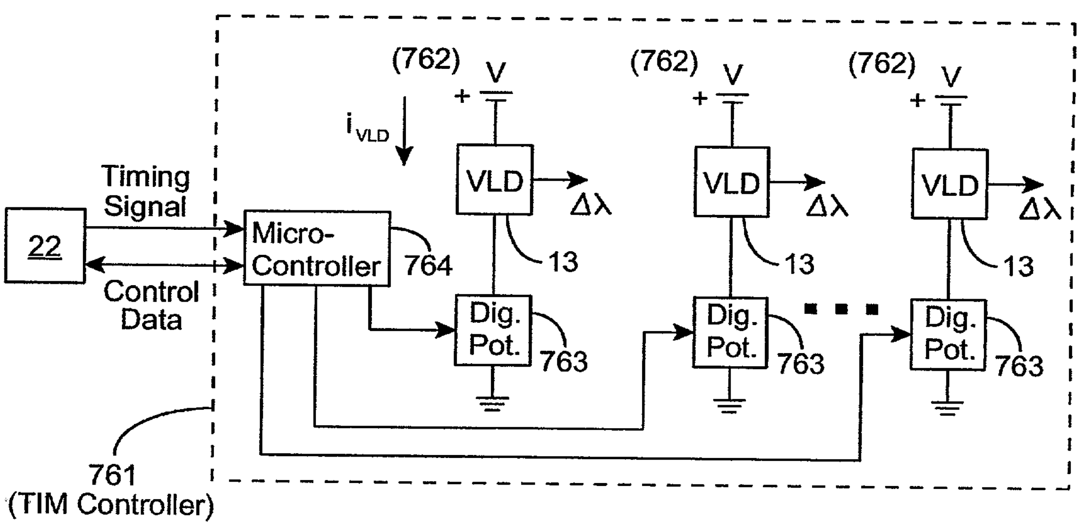


FIG. 1I15D

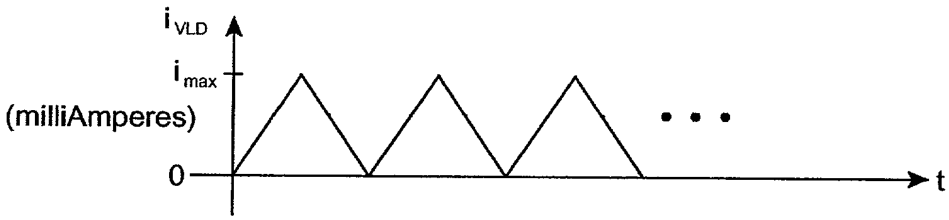


FIG. 1I15E

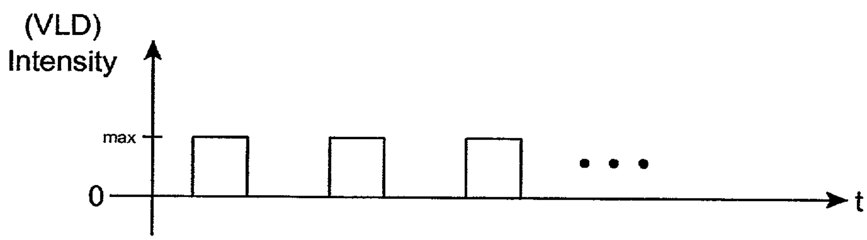


FIG. 1I15F

Third Generalized Method Of Reducing Speckle-Noise Patterns At Image Detection Array Of The IFD Subsystem (3)

(TIMF)

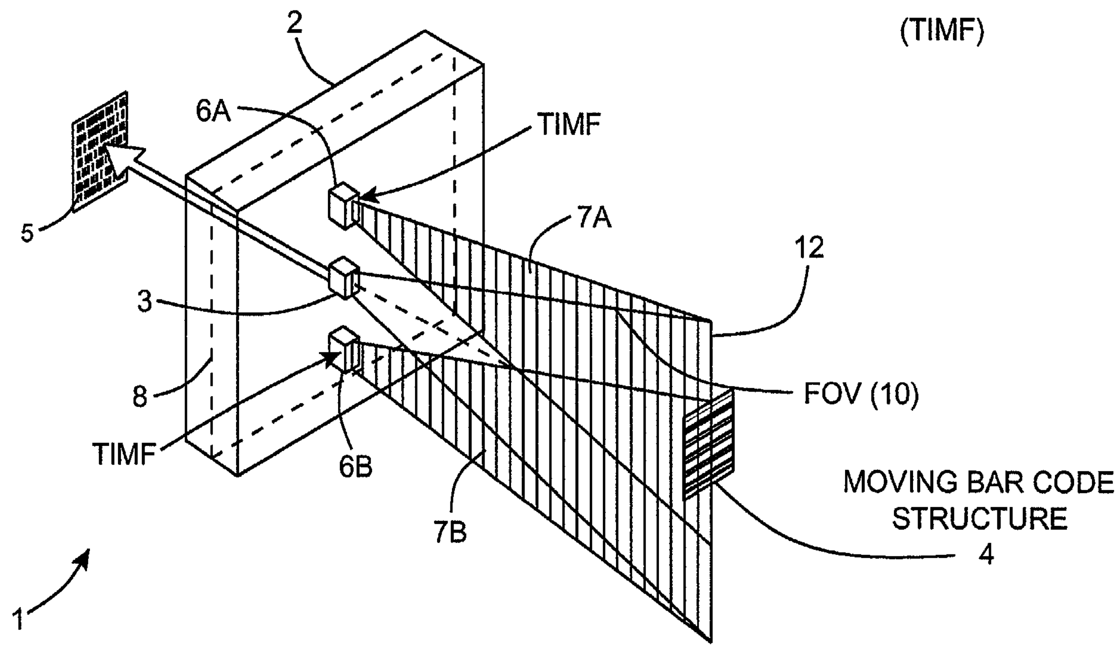
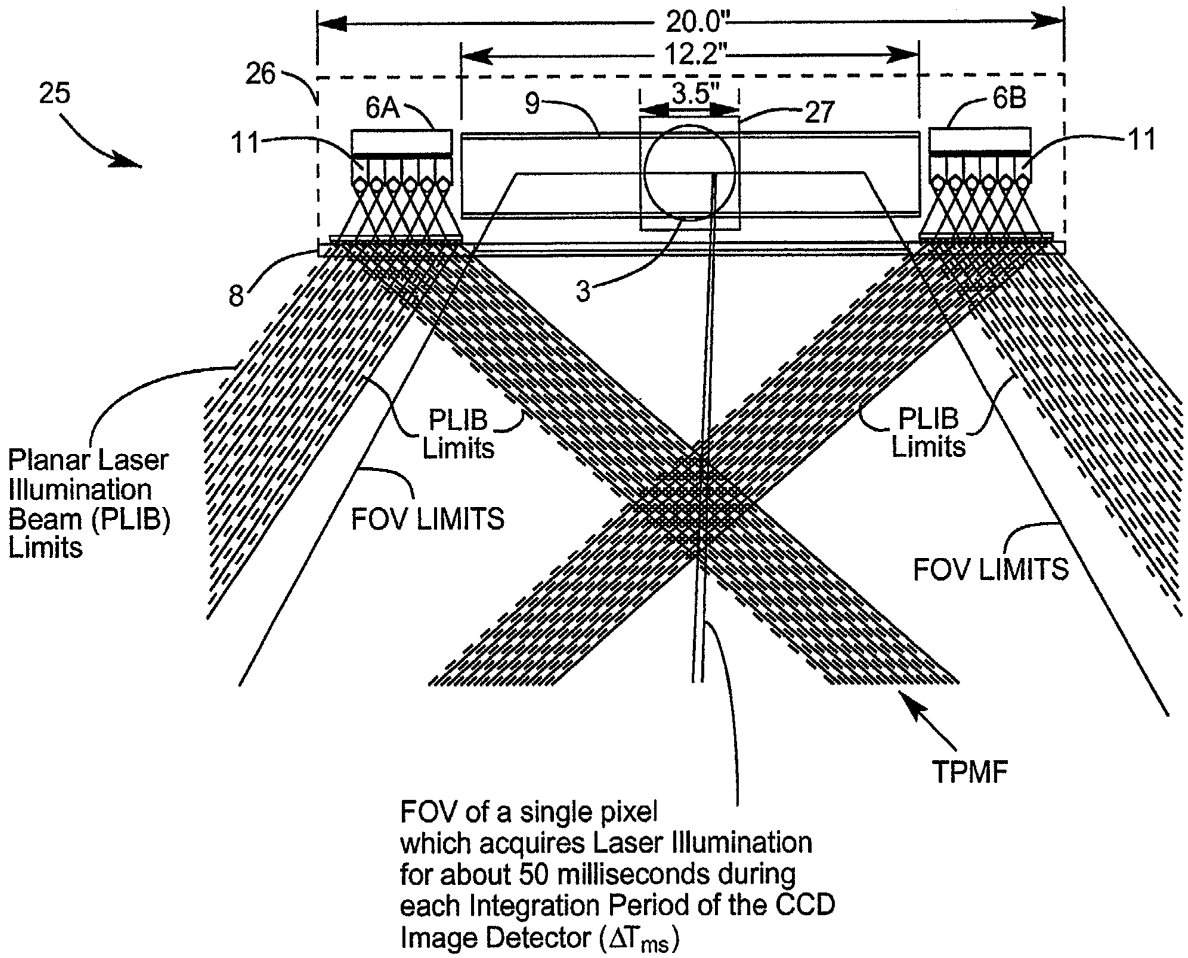


FIG. 1I16



20.0"
12.2"
3.5"
25
26
6A
9
27
6B
11
11
8
3
PLIB
Limits
PLIB
Limits
Planar Laser
Illumination
Beam (PLIB)
Limits
FOV LIMITS
FOV LIMITS
TPMF
FOV of a single pixel
which acquires Laser Illumination
for about 50 milliseconds during
each Integration Period of the CCD
Image Detector (ΔT_{ms})

FIG. 1I16A

THE THIRD GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal phase of the transmitted PLIB according to a temporal phase modulation function (TPMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

A

↓

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the power of the speckle-noise pattern observed at the image detection array.

B

FIG. 1I16B

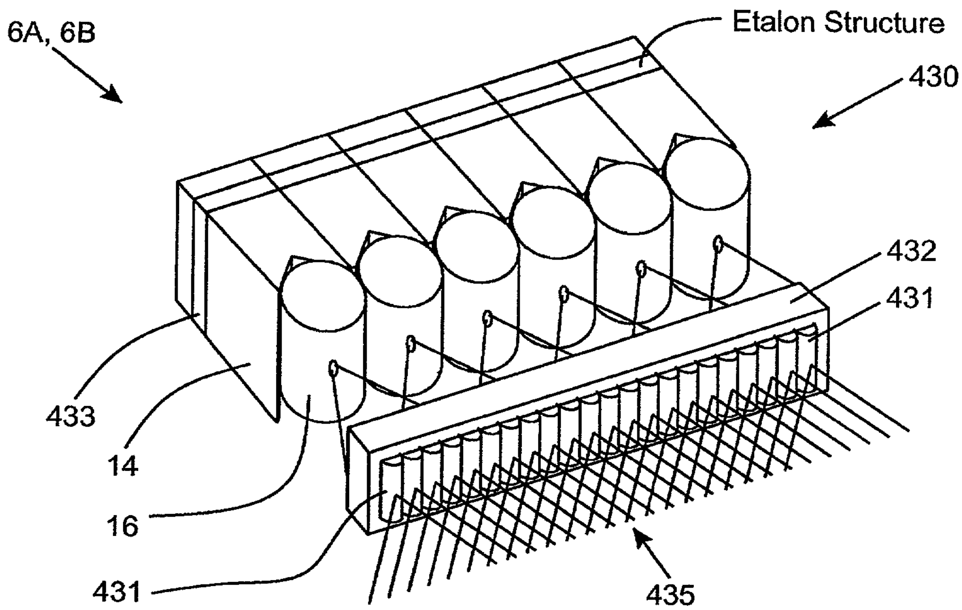


FIG. 1I17A

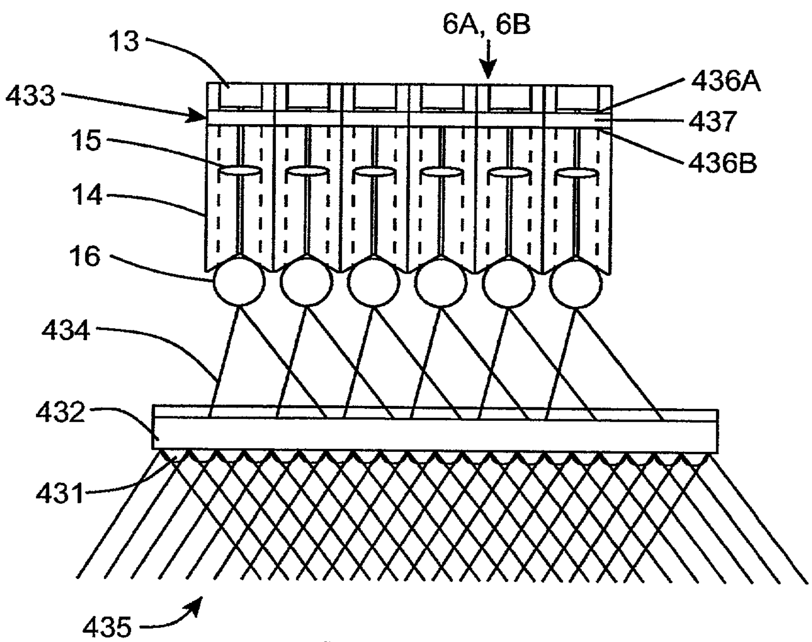


FIG. 1I17B

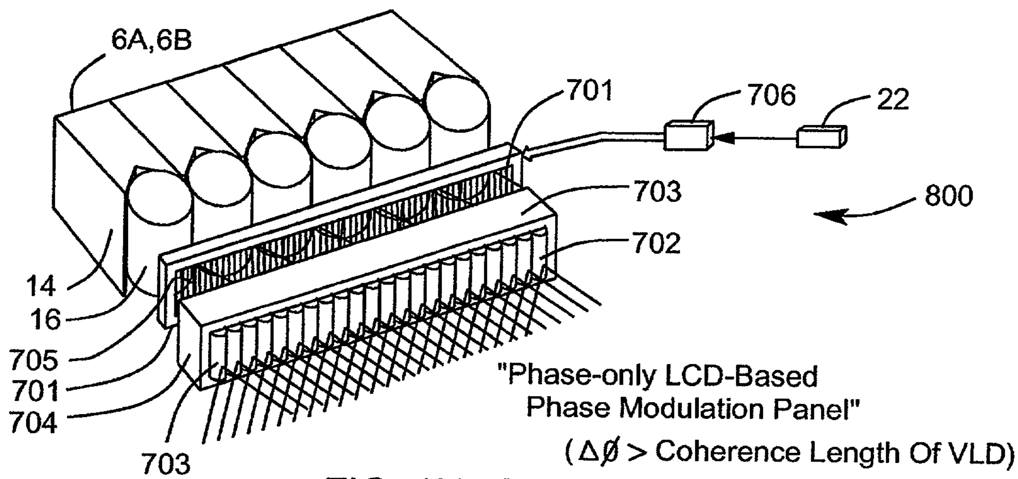


FIG. 1I17C

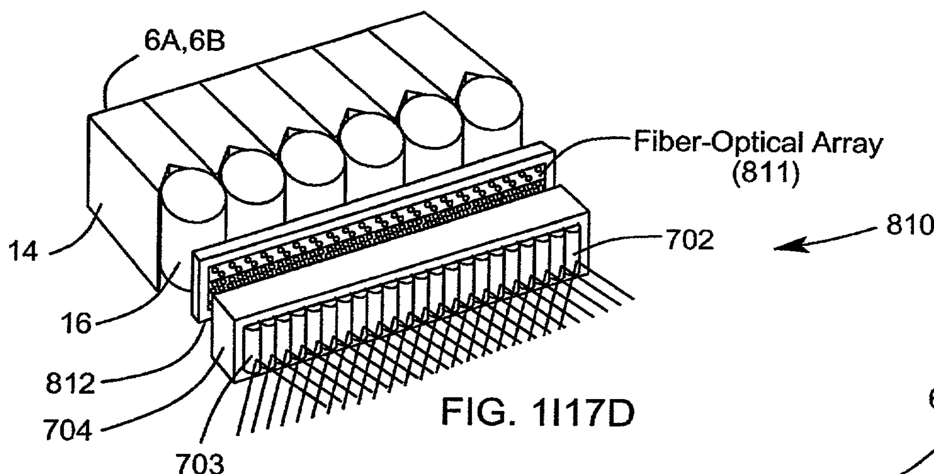


FIG. 1I17D

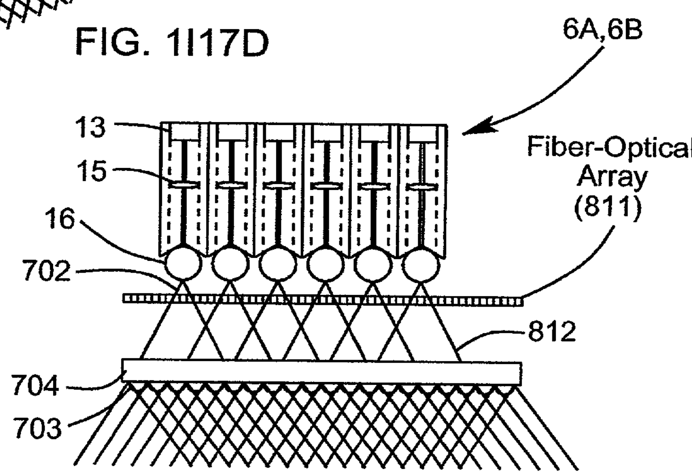


FIG. 1I17E

Fourth Generalized Method Of
Reducing Speckle-Noise Patterns
At Image Detection Array
Of The IFD Subsystem (3)

(TFMF)

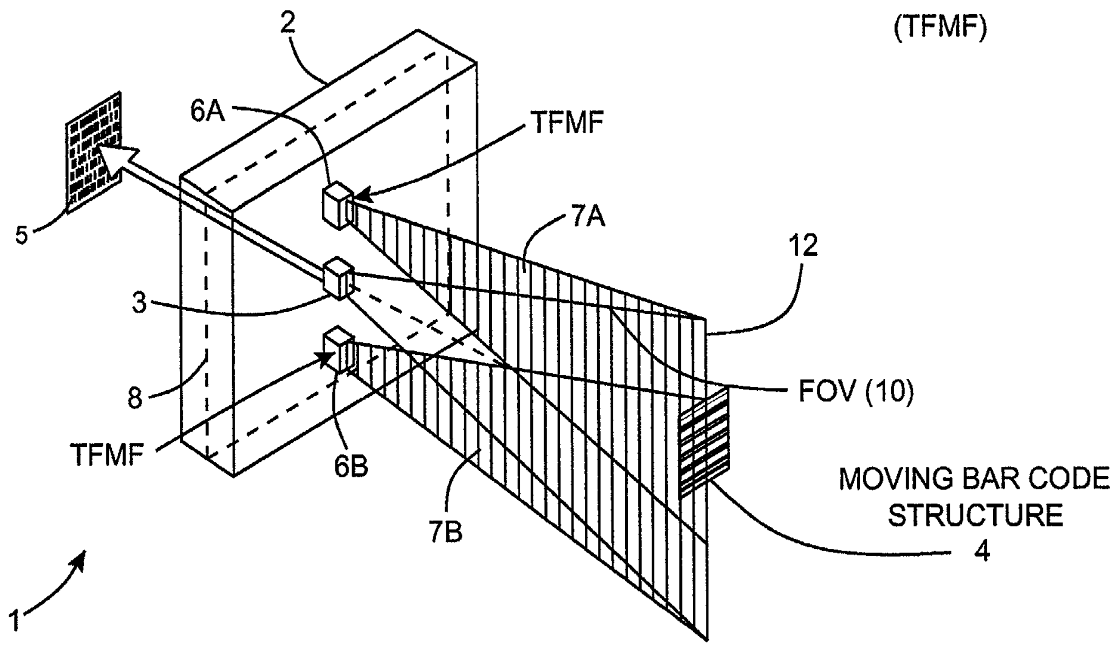


FIG. 1I18

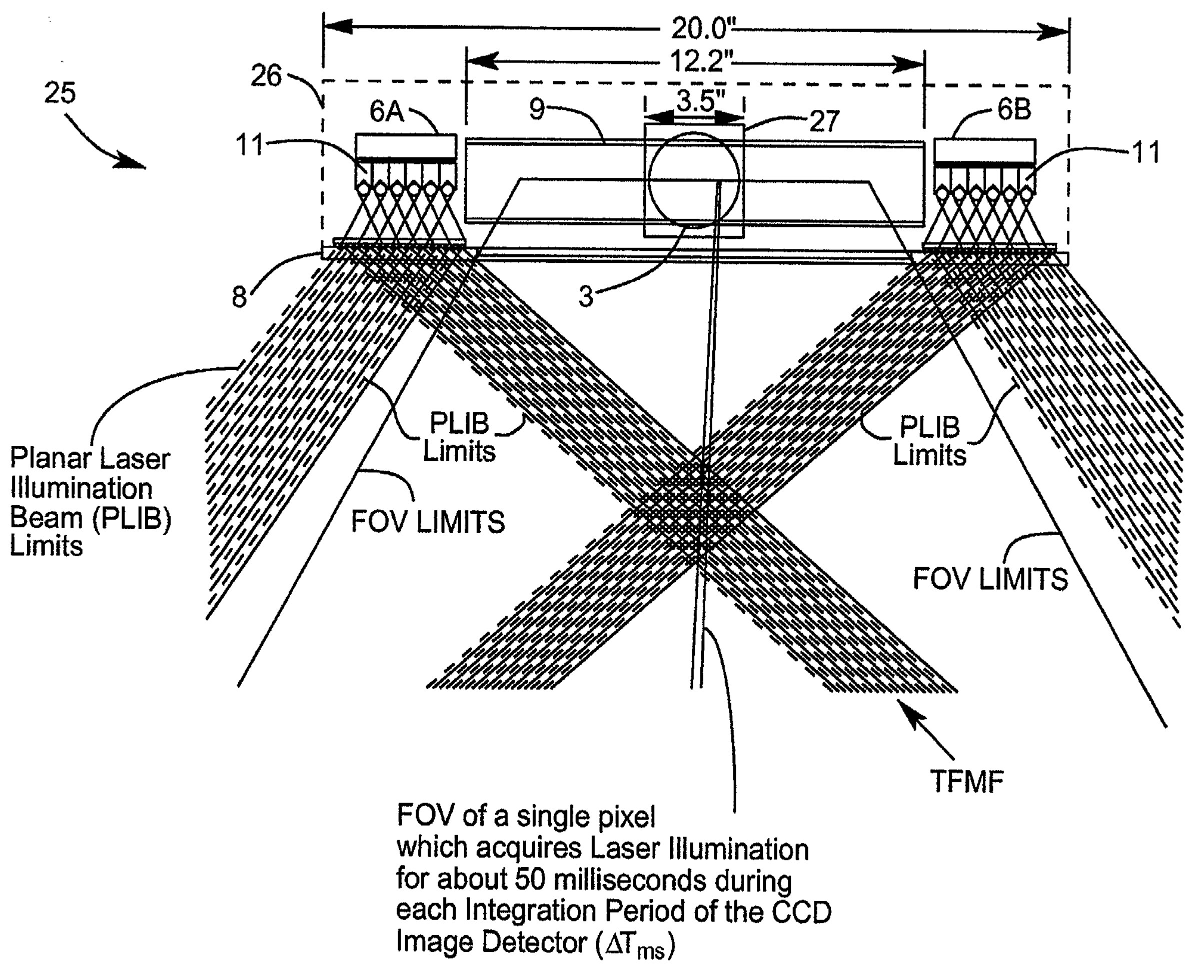

20.0"
12.2"
3.5"
25
26
6A
9
27
6B
11
11
8
3
Planar Laser Illumination Beam (PLIB) Limits
PLIB Limits
PLIB Limits
FOV LIMITS
FOV LIMITS
TFMF
FOV of a single pixel which acquires Laser Illumination for about 50 milliseconds during each Integration Period of the CCD Image Detector (ΔT_{ms})

FIG. 1I18A

THE FOURTH GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal frequency of the transmitted PLIB along the planar extent thereof according to a temporal intensity modulation function (TIMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

A

↓

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the power of the speckle-noise pattern observed at the image detection array.

B

FIG. 1I18B

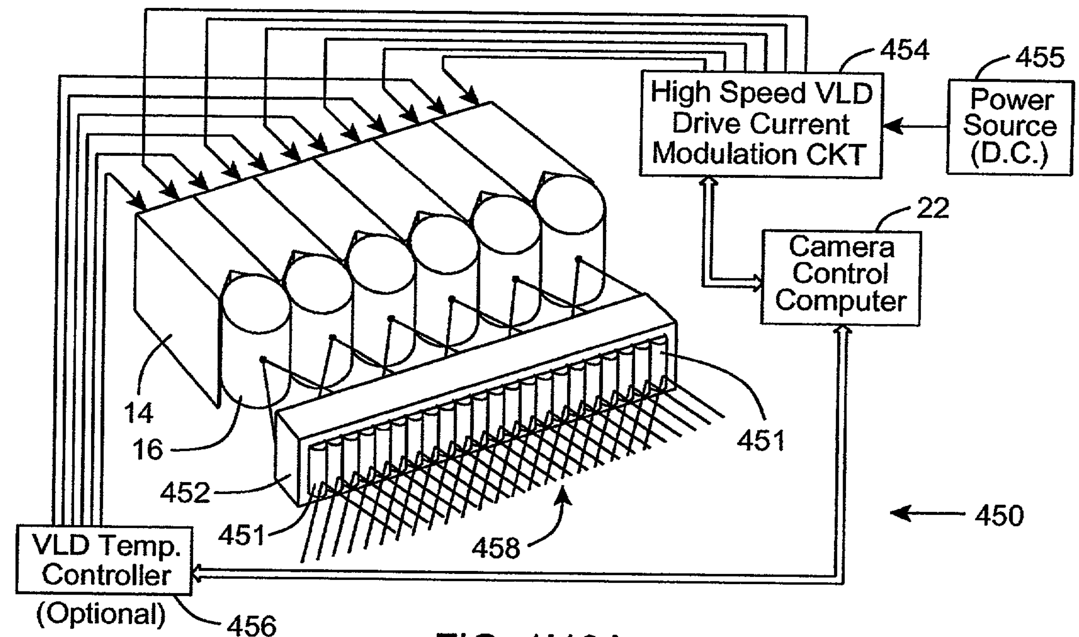


FIG. 1I19A

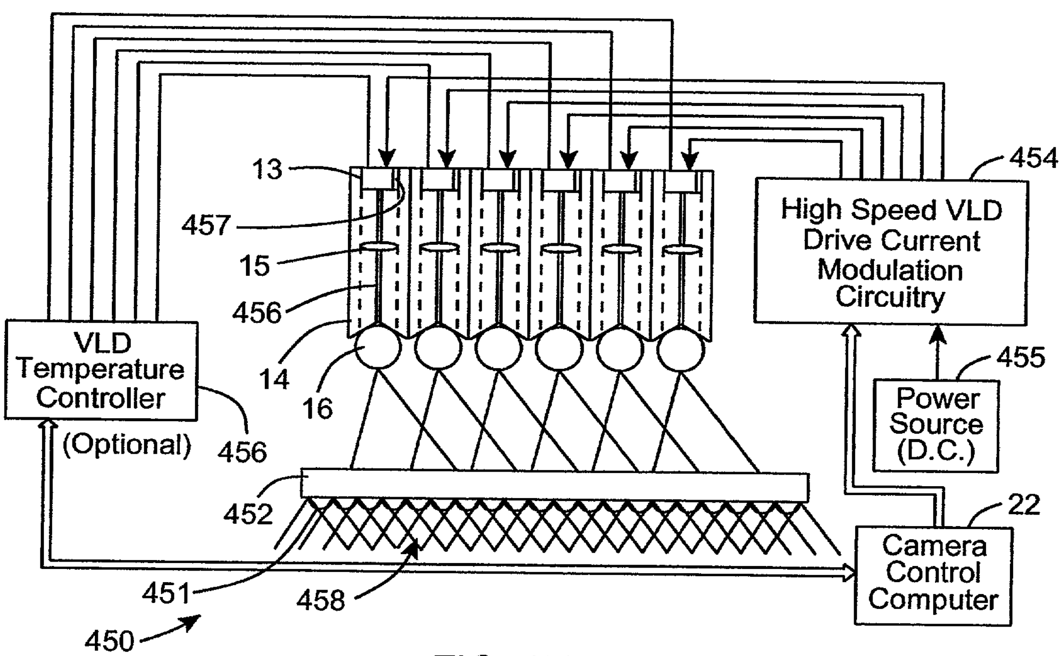


FIG. 1I19B

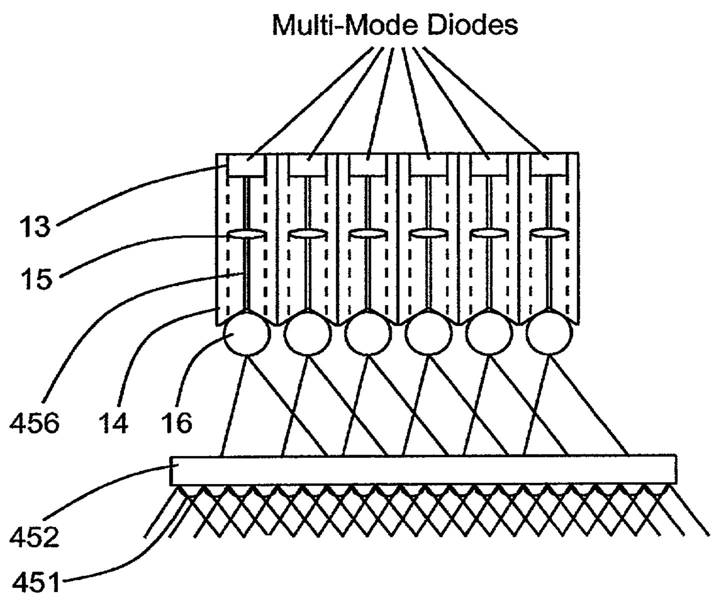


FIG. 1I19C

Fifth Generalized Method Of
Reducing Speckle-Noise Patterns
At Image Detection Array
Of The IFD Subsystem (3)

(SIMF)

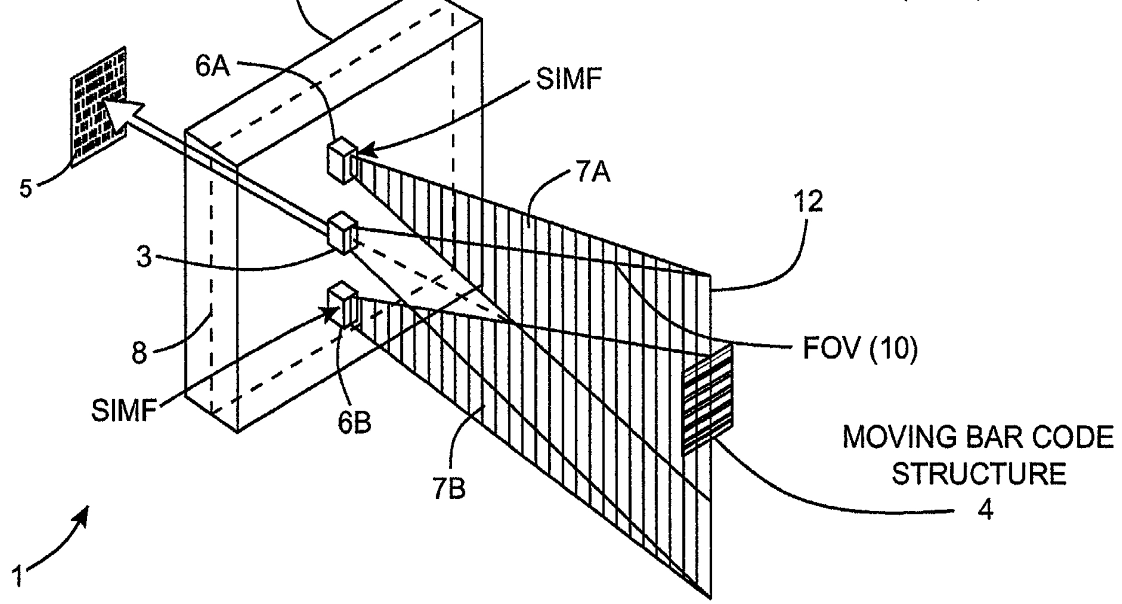
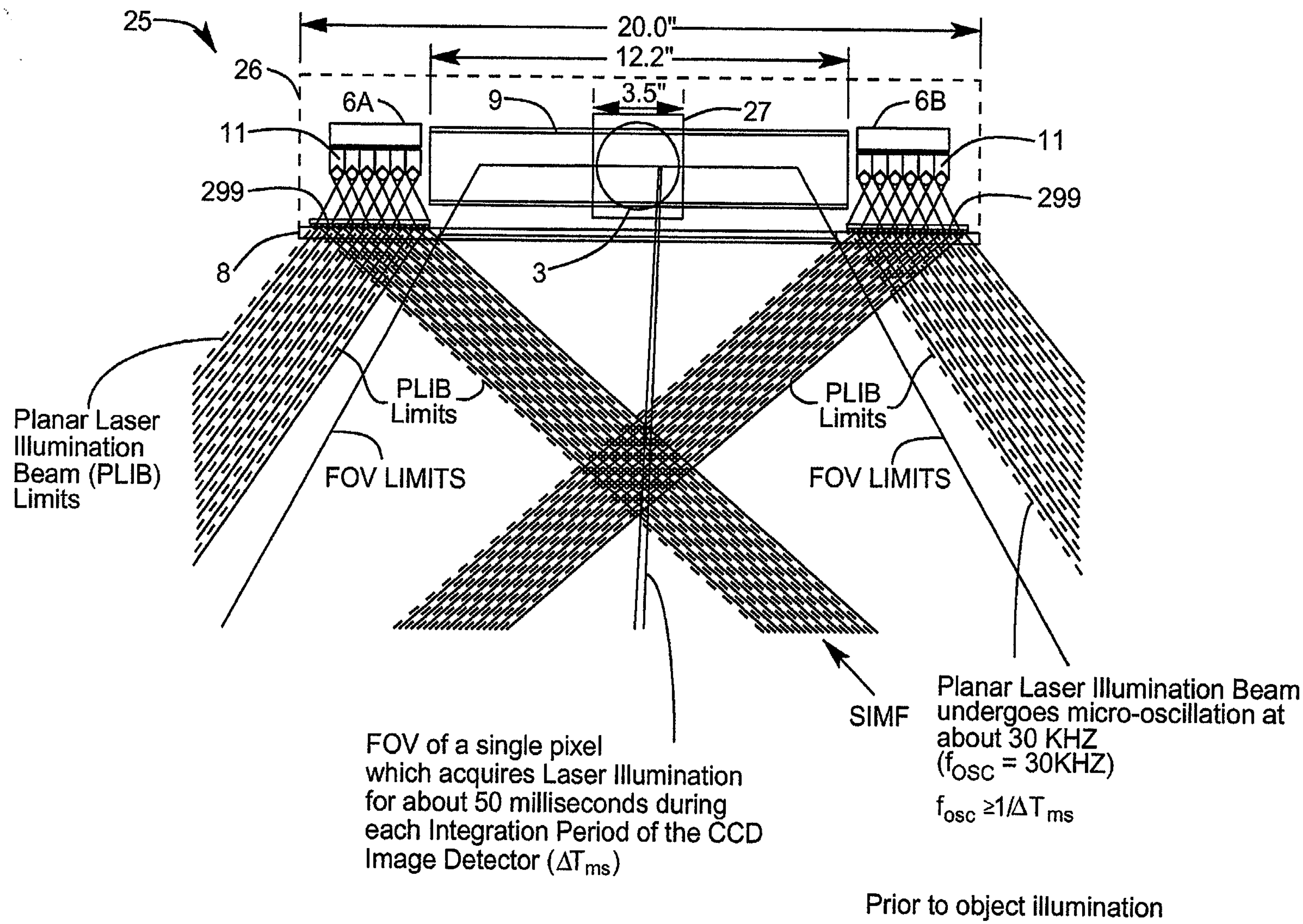


FIG. 1I20



25
20.0"
12.2"
3.5"
26
6A
9
27
6B
11
11
299
299
8
3
Planar Laser Illumination Beam (PLIB) Limits
PLIB Limits
FOV LIMITS
PLIB Limits
FOV LIMITS
SIMF
FOV of a single pixel which acquires Laser Illumination for about 50 milliseconds during each Integration Period of the CCD Image Detector (ΔT_{ms})
Planar Laser Illumination Beam undergoes micro-oscillation at about 30 KHZ (f_{OSC} = 30KHZ)
$f_{osc} \geq 1/\Delta T_{ms}$
Prior to object illumination

FIG. 1I20A

THE FIFTH GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

Prior to illumination of the target with the planar laser illumination beam (PLIB), modulate the spatial intensity of the transmitted PLIB along the planar extent thereof according to a spatial intensity modulation function (SIMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

A

Temporally average the numerous substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the power of the speckle-noise pattern observed at the image detection array.

B

FIG. 1I20B

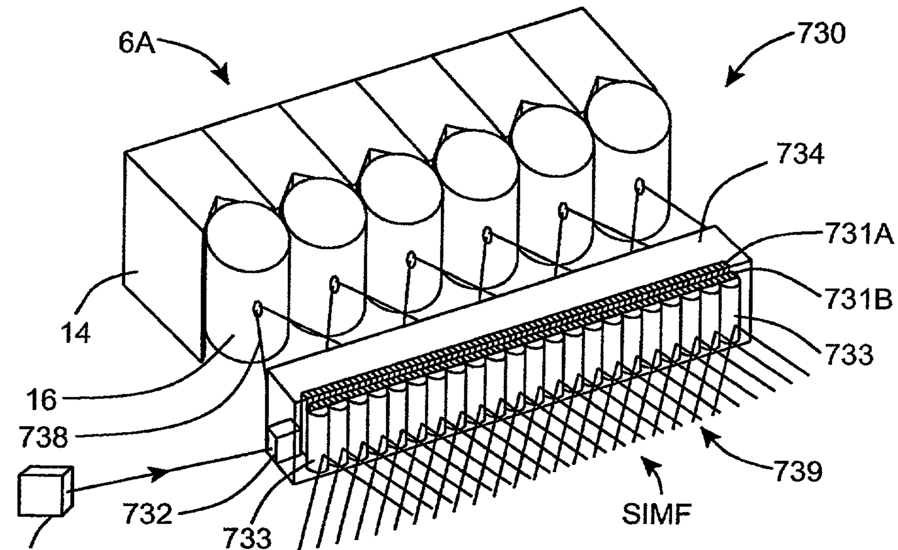


FIG. 1I21A

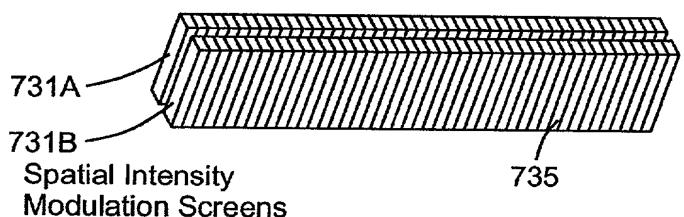


FIG. 1I21B

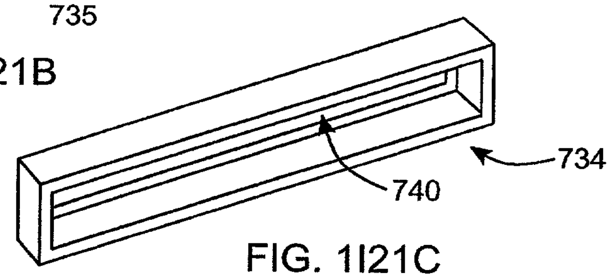


FIG. 1I21C

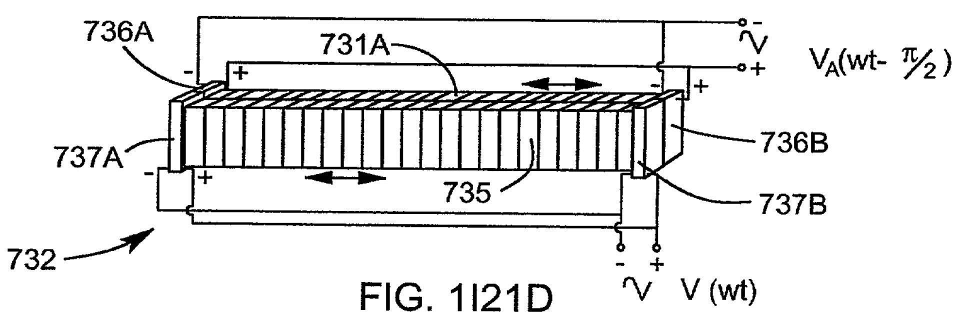


FIG. 1I21D

Sixth Generalized Method Of
Reducing Speckle-Noise Patterns
At Image Detection Array
Of The IFD Subsystem (3)

(SIMF)

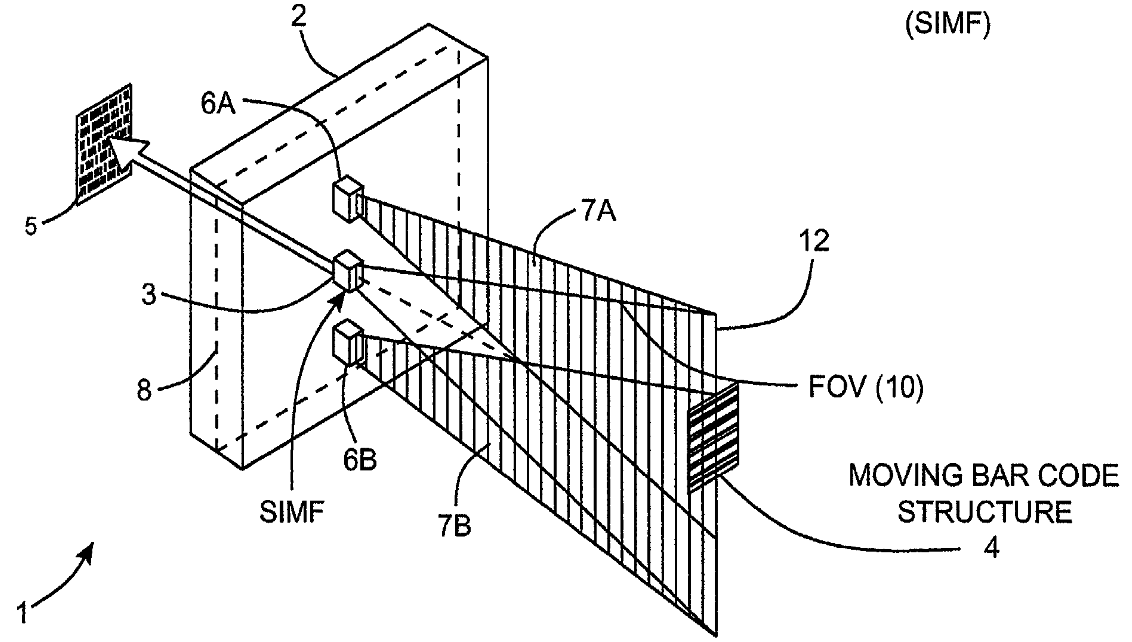


FIG. 1I22

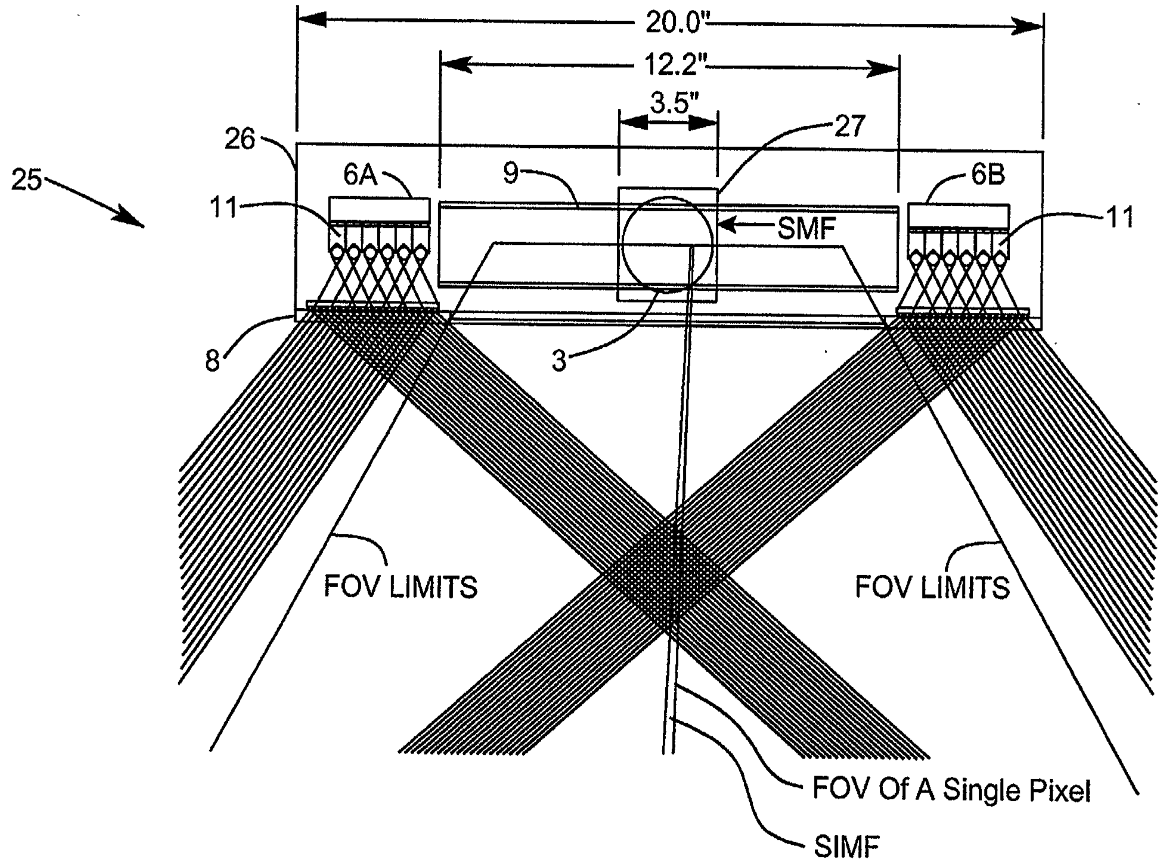

20.0"
12.2"
3.5"
27
26
25
6A
9
6B
11
SMF
11
8
3
FOV LIMITS
FOV LIMITS
FOV Of A Single Pixel
SIMF

FIG. 1I22A

THE SIXTH GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

After illumination of the target with the planar laser illumination beam (PLIB), modulate the spatial intensity of the reflected/scattered (i.e. received) PLIB along the planar extent thereof according to a spatial intensity modulation function (SIMF) so as to produce numerous substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof. A

↓

Temporally average the many substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the speckle-noise pattern observed at the image detection array. B

FIG. 1I22B

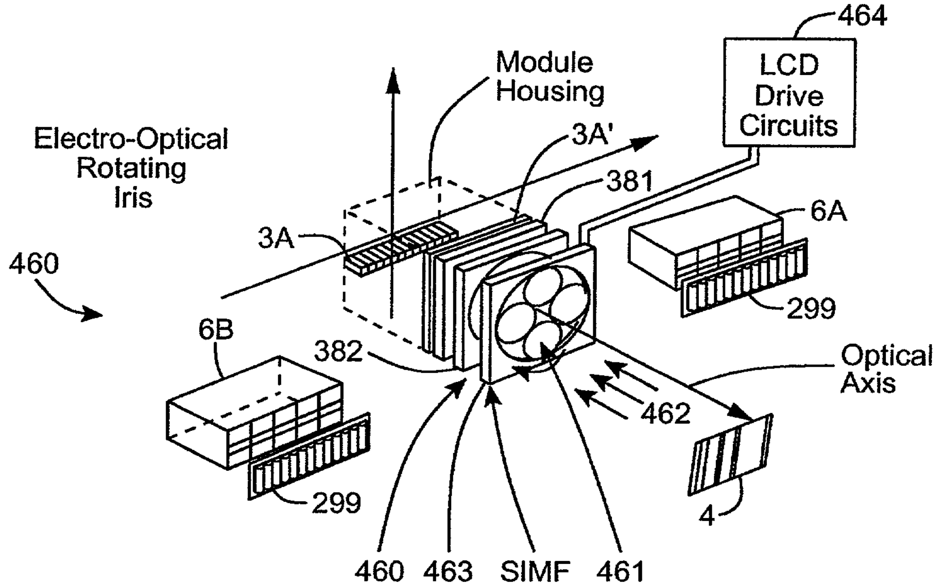


FIG. 1I23A

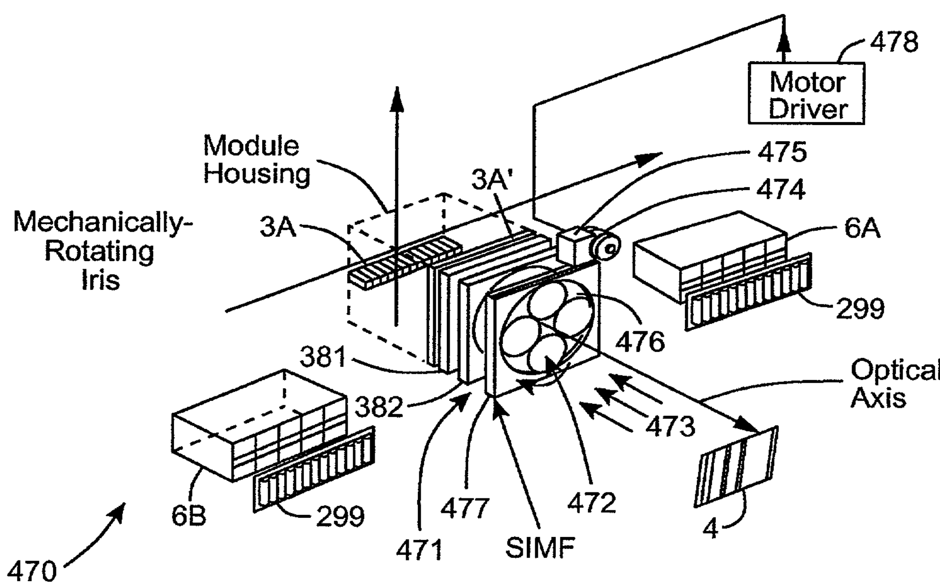


FIG. 1I23B

Seventh Generalized Method Of
Reducing Speckle-Noise Patterns
At Image Detection Array
Of The IFD Subsystem (3)

(TIMF)

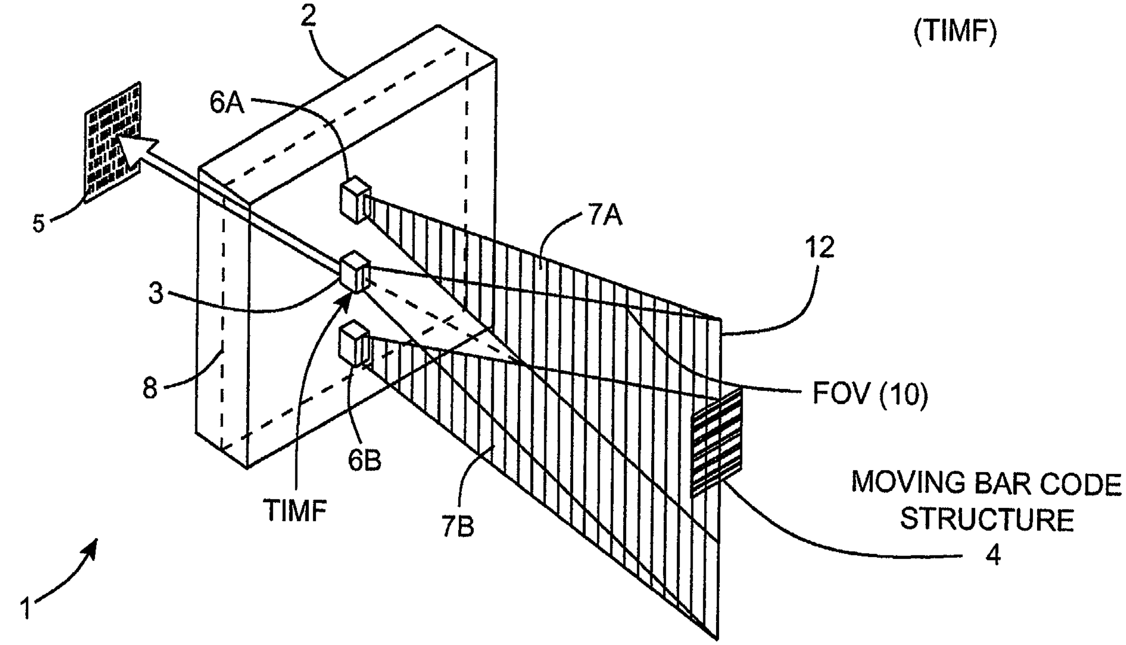


FIG. 1I24

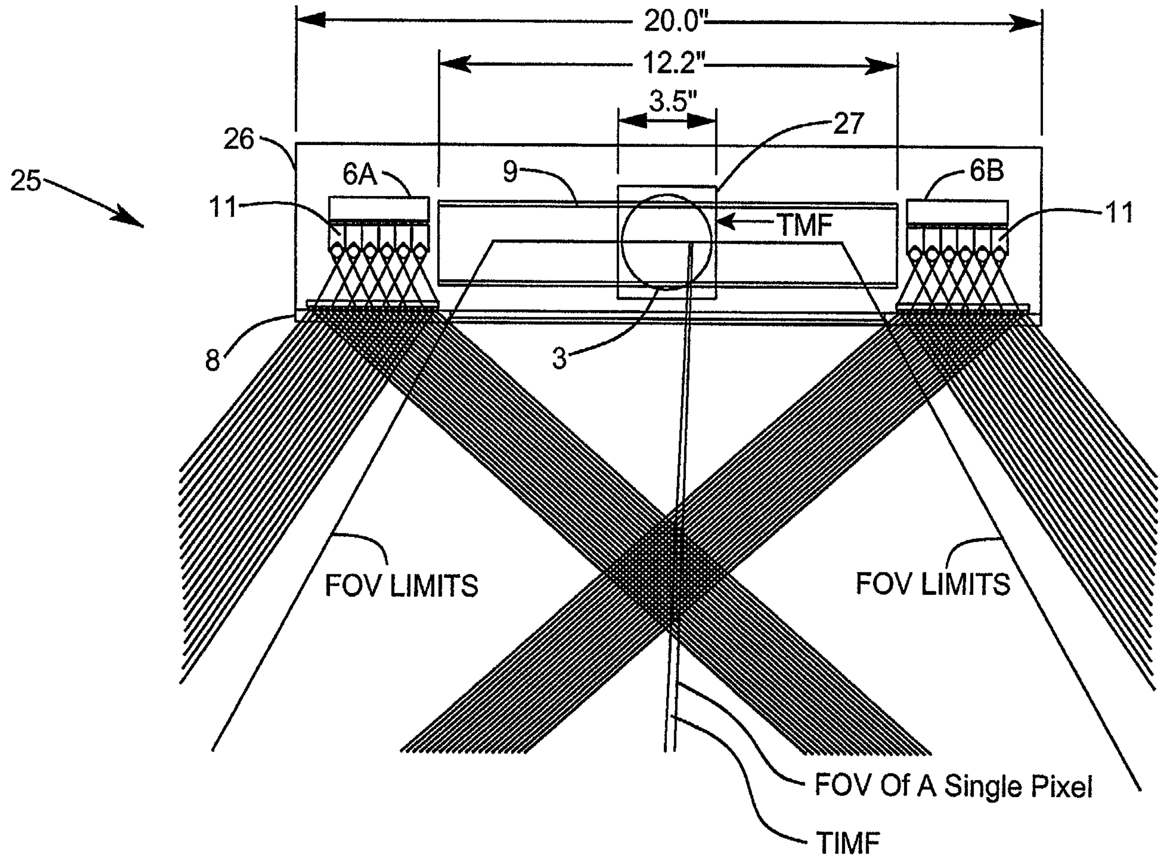

20.0"
12.2"
3.5"
27
26
25
6A
9
6B
11
TMF
11
8
3
FOV LIMITS
FOV LIMITS
FOV Of A Single Pixel
TIMF

FIG. 1I24A

THE SEVENTH GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

After illumination of the target with the planar laser illumination beam (PLIB), modulate the temporal intensity of the reflected/scattered (i.e. received) PLIB along the planar extent thereof according to a temporal intensity modulation function (TIMF) so as to produce many substantially different time-varying speckle-noise patterns at the image detection array of the IFD Subsystem during the photo-integration time period thereof.

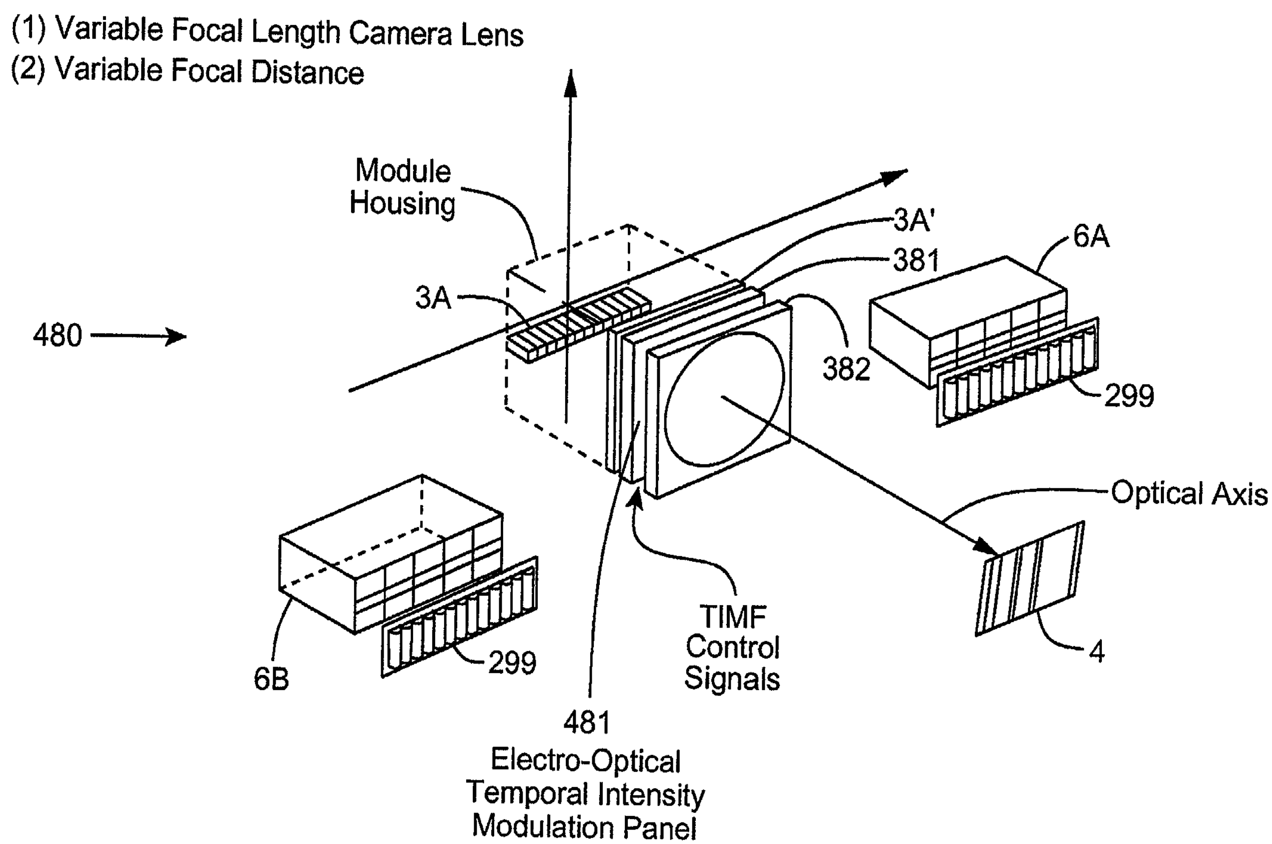
A

↓

Temporally average the many substantially different time-varying speckle-noise patterns produced at the image detection array in the IFD Subsystem during the photo-integration time period thereof, so as to thereby reduce the speckle-noise pattern observed at the image detection array.

B

FIG. 1I24B



(1) Variable Focal Length Camera Lens
(2) Variable Focal Distance
Module Housing
3A
480
3A'
381
6A
382
299
Optical Axis
6B
299
TIMF Control Signals
4
481
Electro-Optical Temporal Intensity Modulation Panel

FIG. 1I24C

THE EIGHT GENERALIZED SPECKLE-NOISE PATTERN REDUCTION METHOD OF THE PRESENT INVENTION

Use a PLIIM-BASED Imager to produce a series of consecutively captured digital images of an object over a series of photo-integration time periods of the PLIIM-Based Imager, wherein each digital image of the object includes a substantially different speckle noise pattern produced by natural oscillatory micro-motion and/or forced oscillatory micro-movementof the Imager relative to the object during operation of the PLIIM-Based Imager. — A

↓

Store the series of consecutively captured digital images of the object in buffer memory within the PLIIM-Based Imager. — B

↓

Add relatively small (e.g. 3x3) windowed image processing filters to the additively combine and average the pixel data in the series of consecutively captured digital images so as to produce a reconstructed digital image having a speckle noise pattern with reduced RMS power. — C

FIG. 1I24D

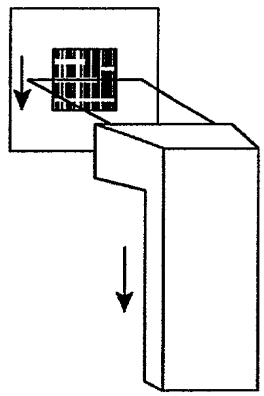
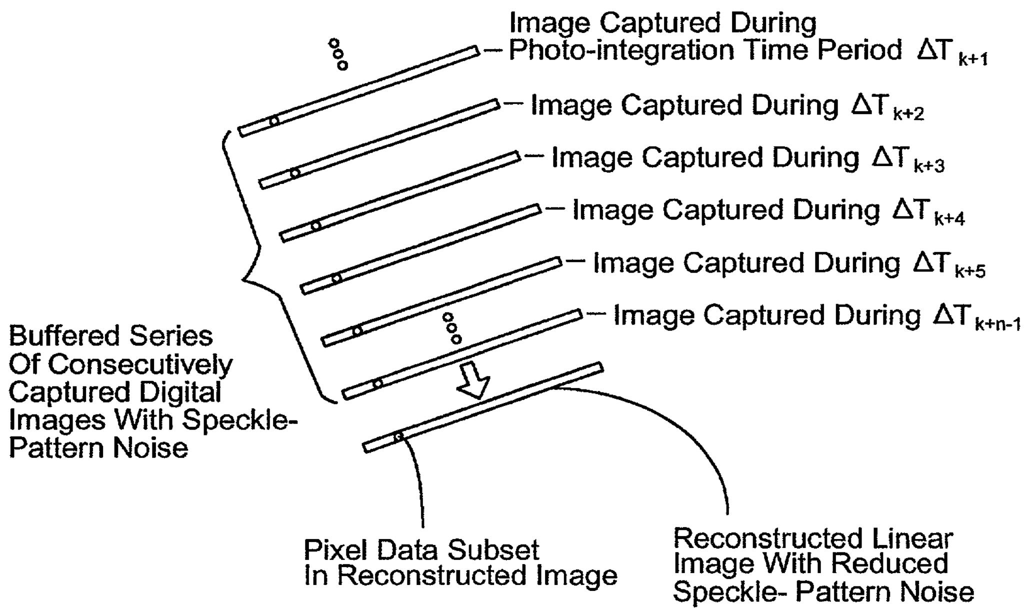


FIG. 1I24E



Case: Linear Imager

FIG. 1I24F

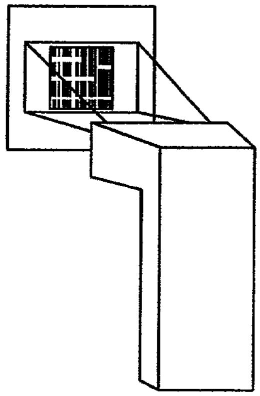
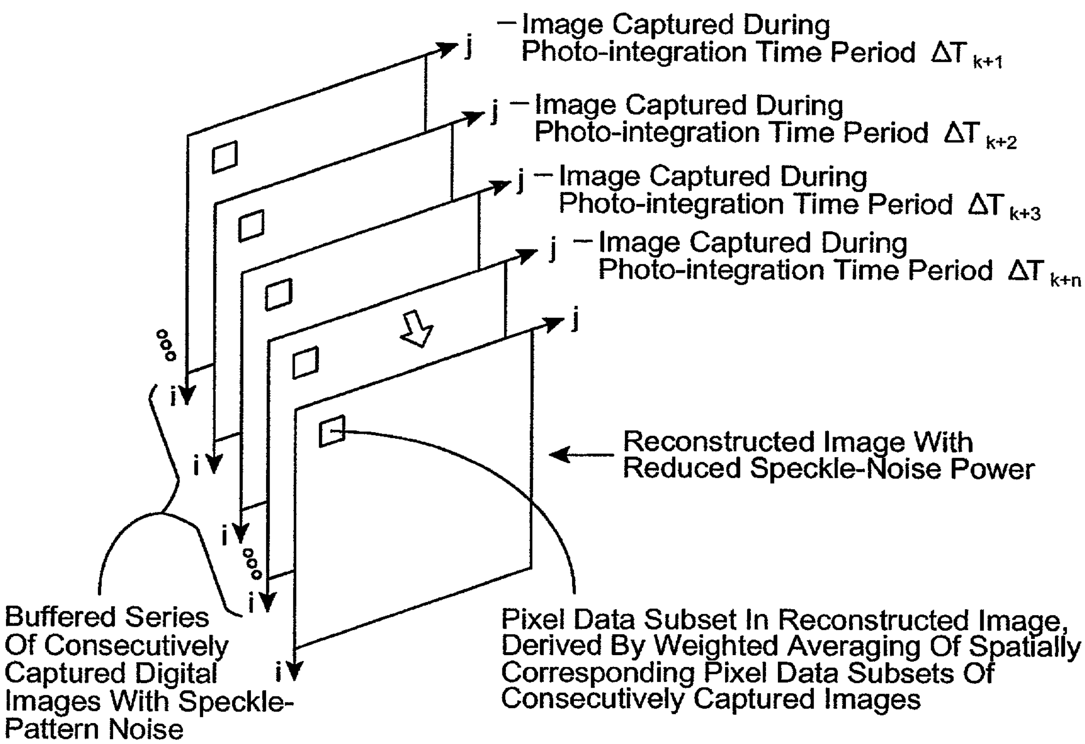


FIG. 1I24G



Case: 2D Area Imager

FIG. 1I24H

THE NINTH GENERALIZED METHOD OF REDUCING SPECKLE PATTERN NOISE IN PLIIM-BASED IMAGING SYSTEMS

During each photo-integration time period of a PLIIM-Based Imager, produce numerous substantially different spatially-varying speckle noise pattern elements (i.e. speckle noise pattern elements at different points) on each image detection element in the image detection array of the PLIIM-Based Imager. A

↓

Spatially (and temporally) average said spatially-varying speckle-noise pattern elements over the spatial area of each image detection element, thereby reducing the RMS power of speckle-pattern noise observed in said PLIM-Based Imager. B

FIG. 1I24I

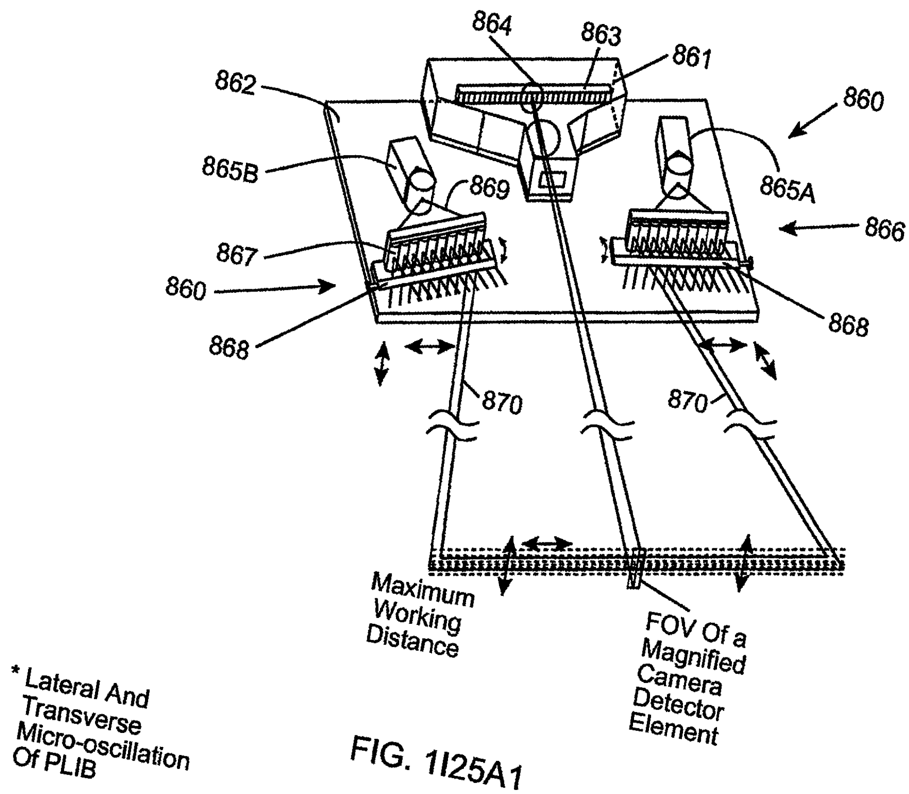


FIG. 1I25A1

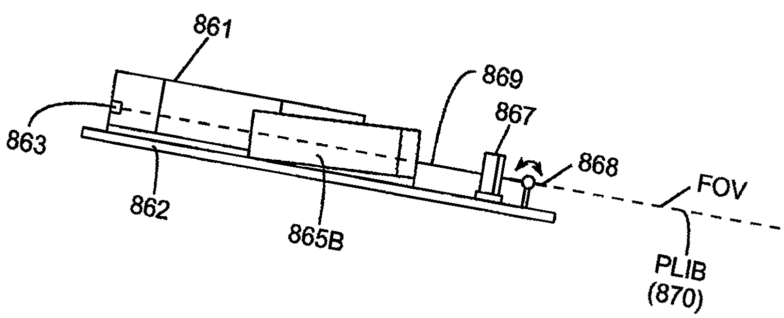


FIG. 1I25A2

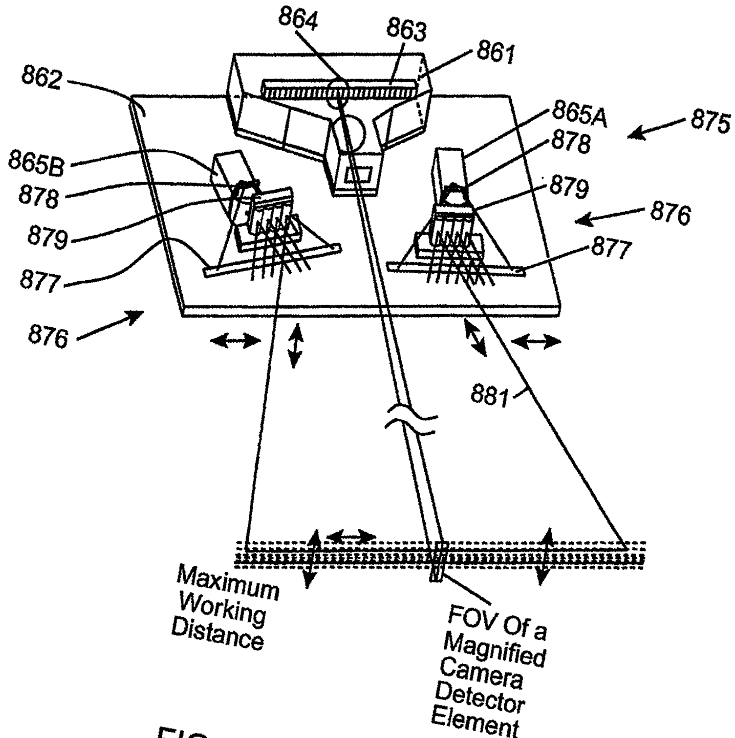


FIG. 1I25B1

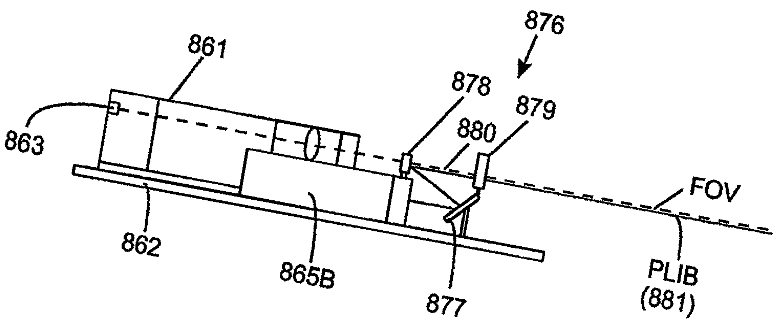
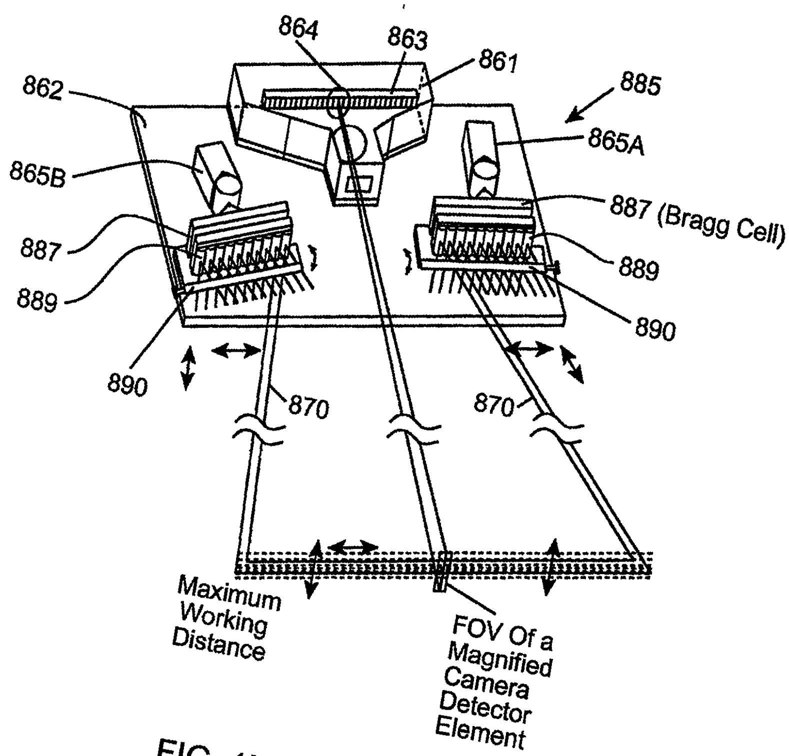


FIG. 1I25B2



* Lateral And Transverse Micro-oscillation Of PLIB

FIG. 1I25C1

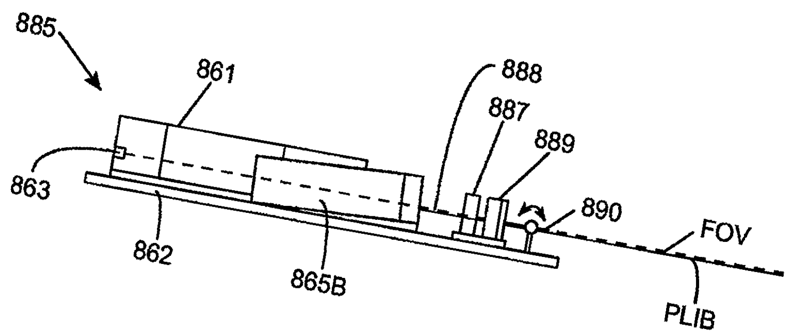


FIG. 1I25C2

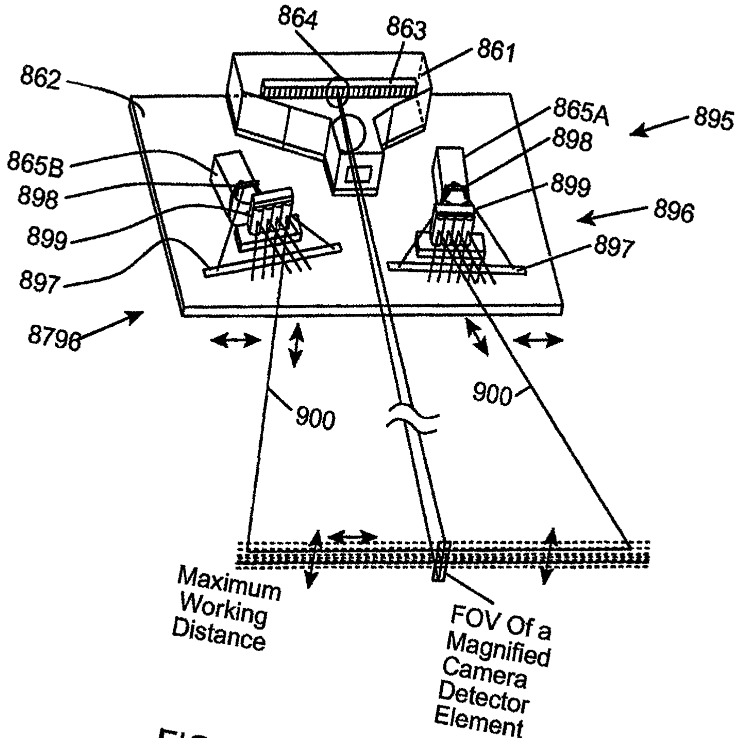


FIG. 1I25D1

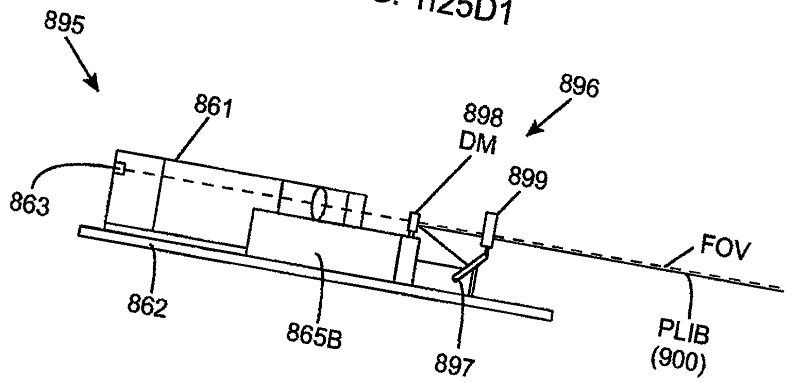


FIG. 1I25D2

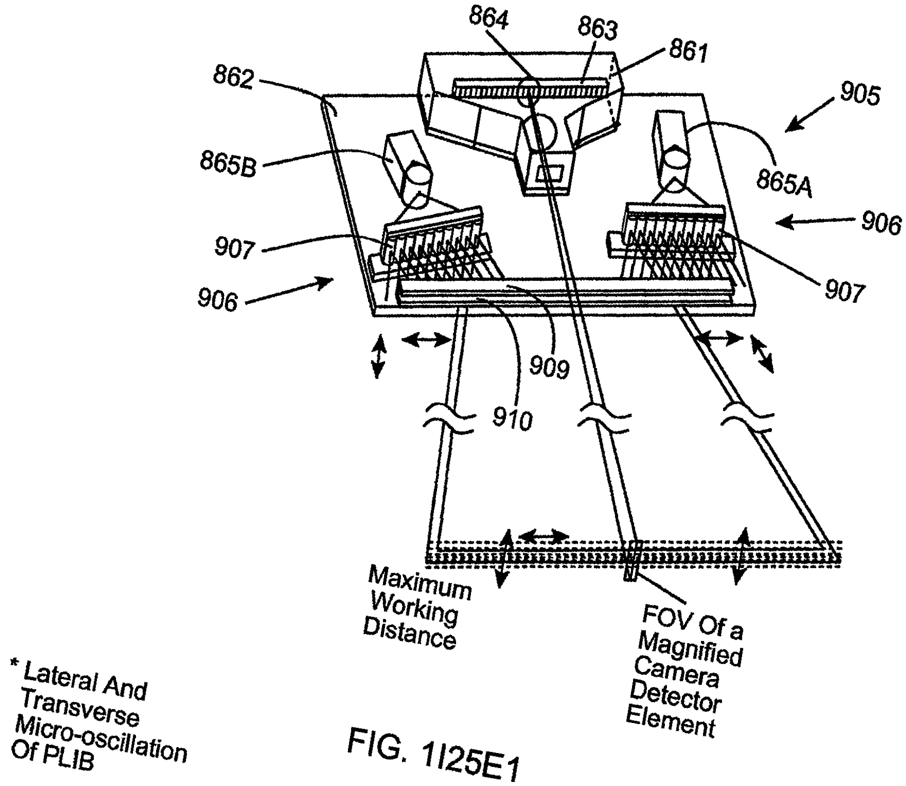


FIG. 1I25E1

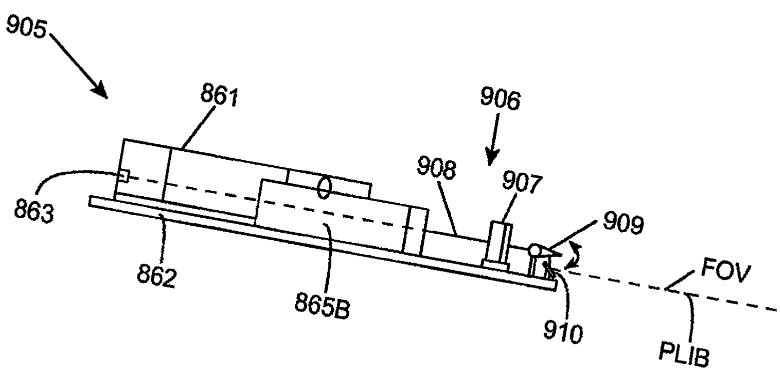


FIG. 1I25E2

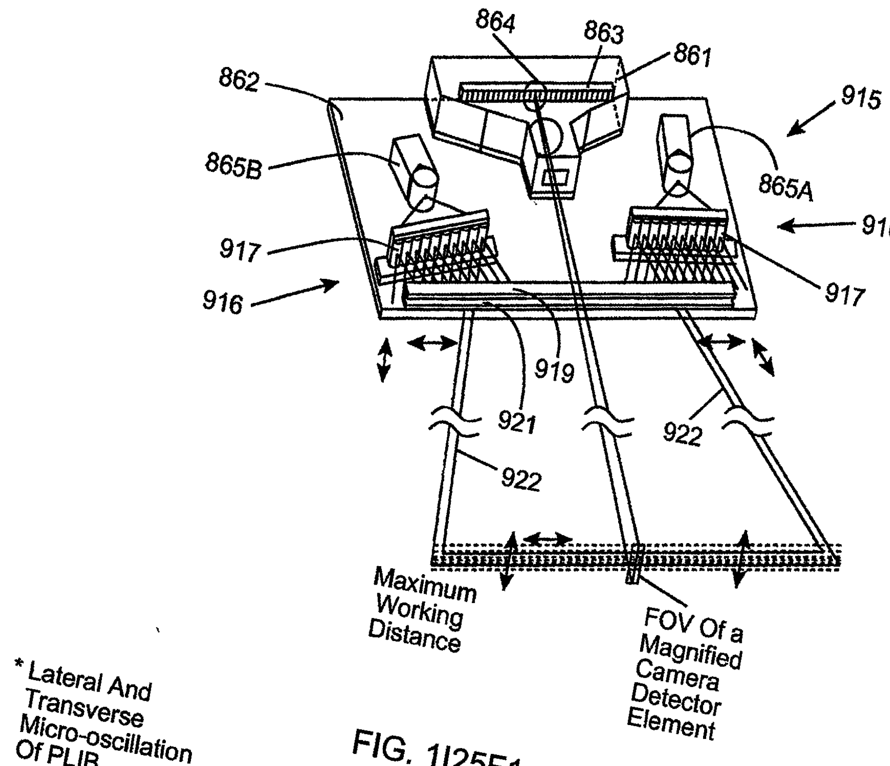


FIG. 1I25F1

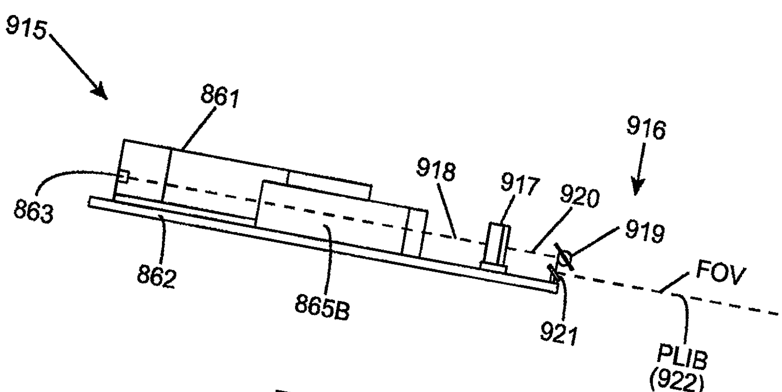


FIG. 1I25F2

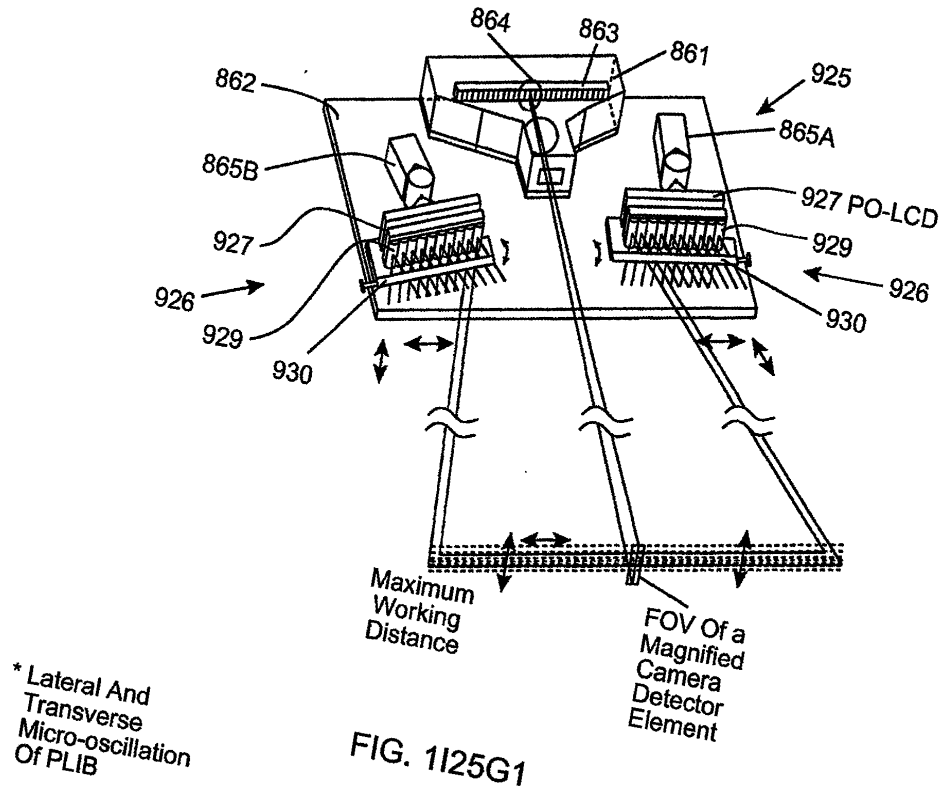


FIG. 1I25G1

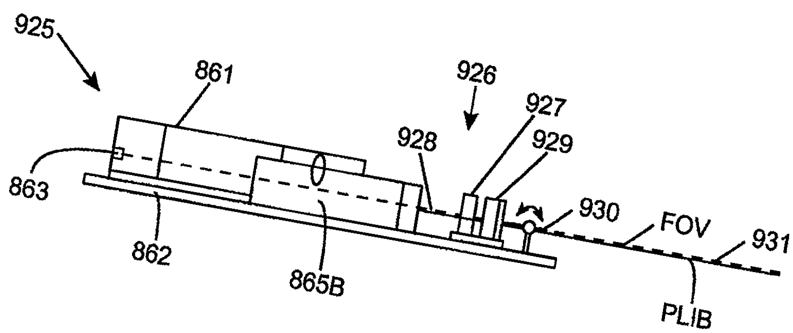


FIG. 1I25G2

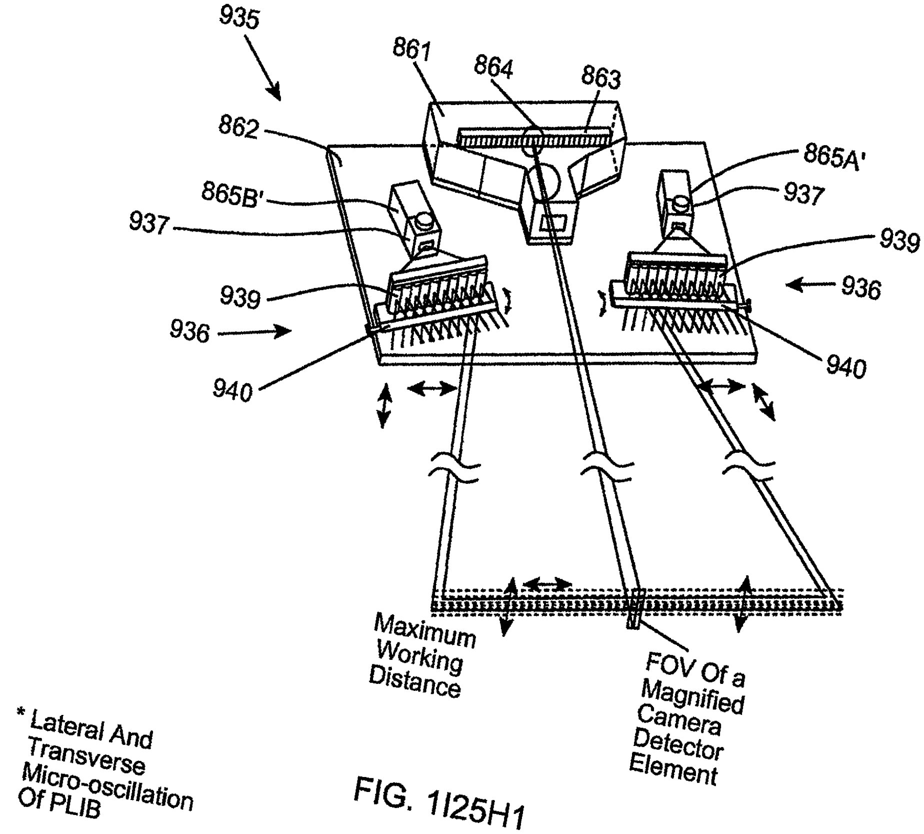


FIG. 1I25H1

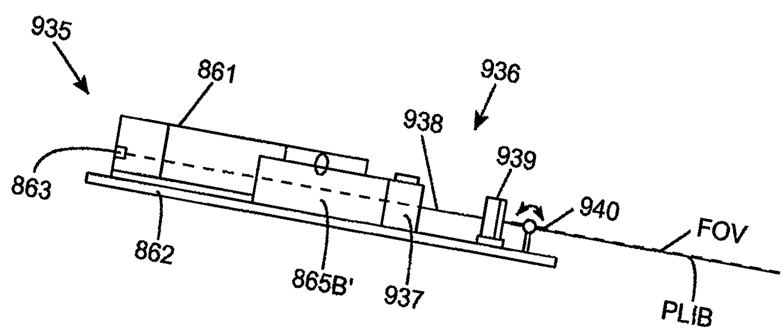


FIG. 1I25H2

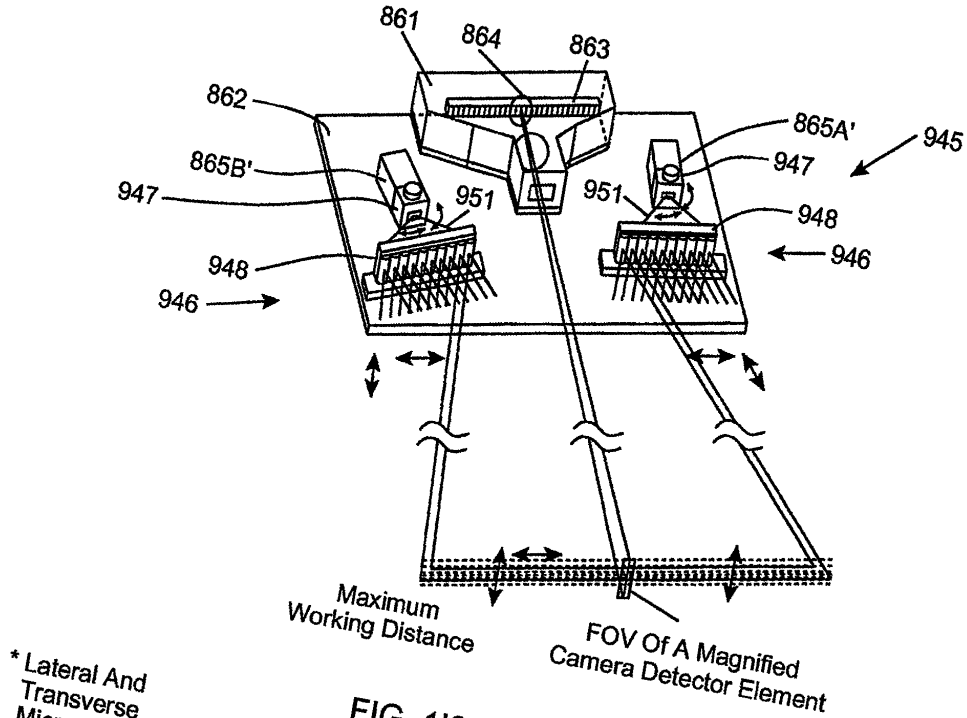


FIG. 1I25I1

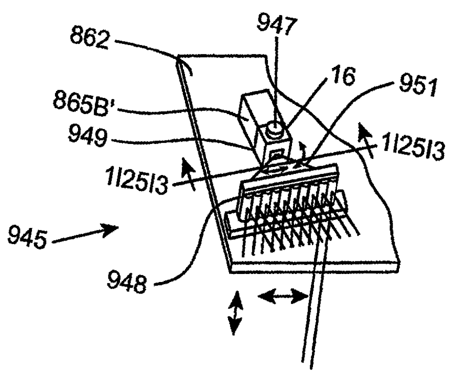


FIG. 1I25I2

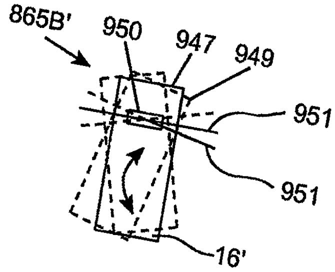


FIG. 1I25I3

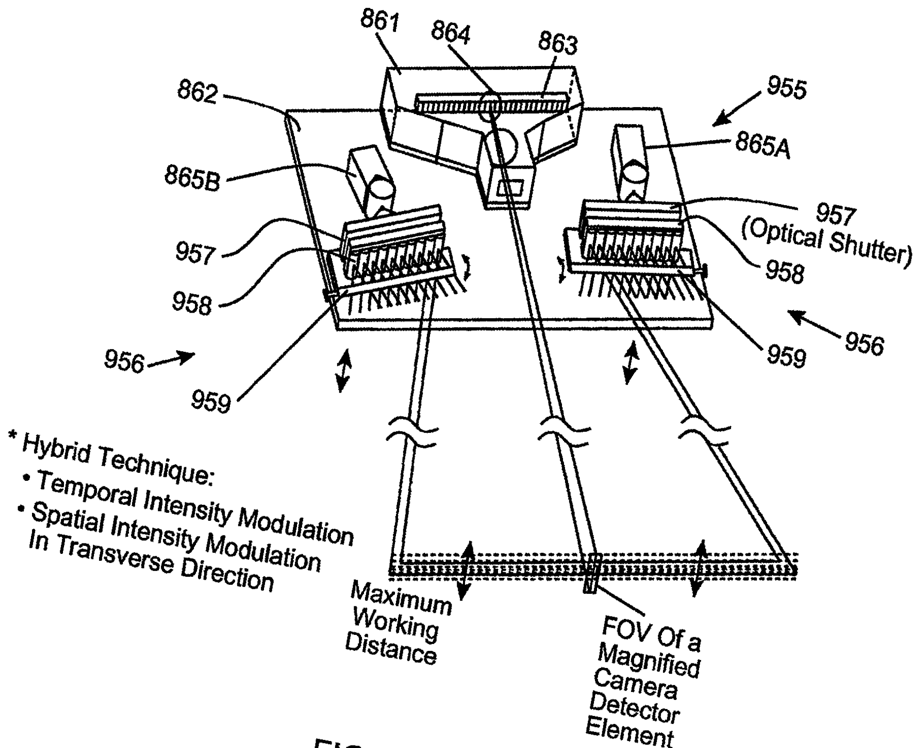


FIG. 1I25J1

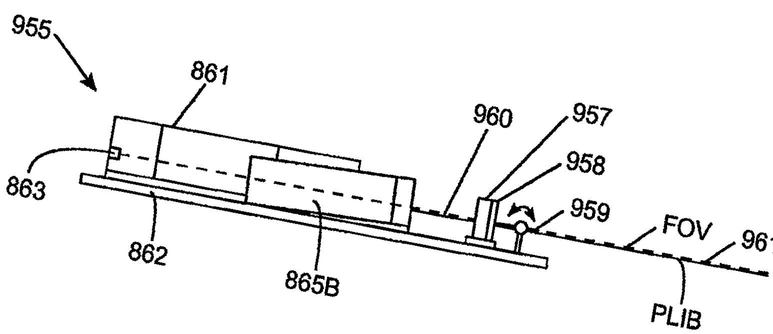


FIG. 1I25J2

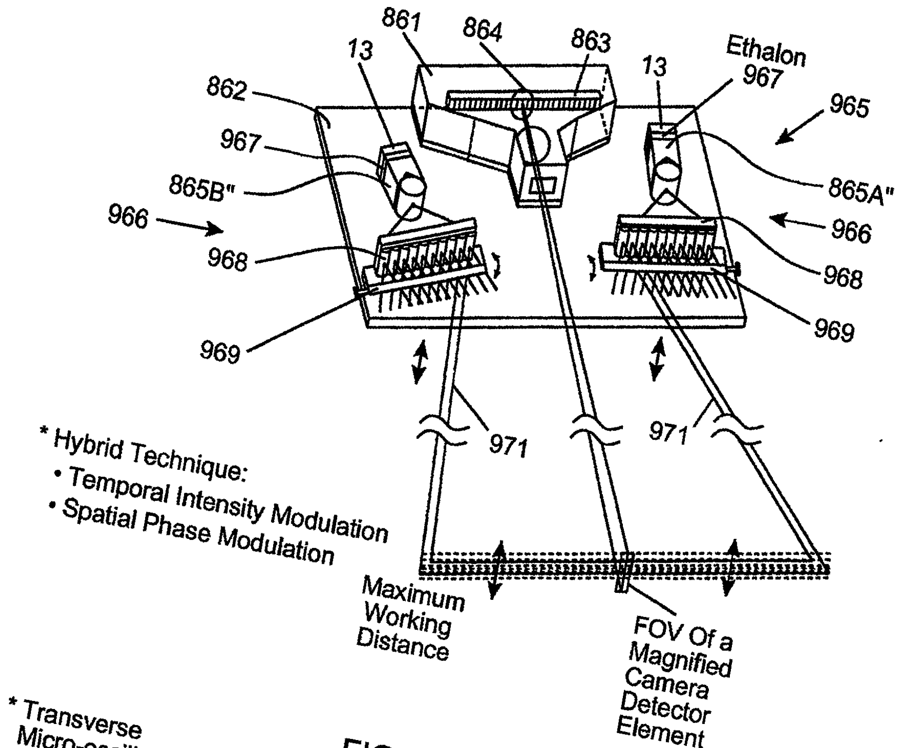


FIG. 1I25K1

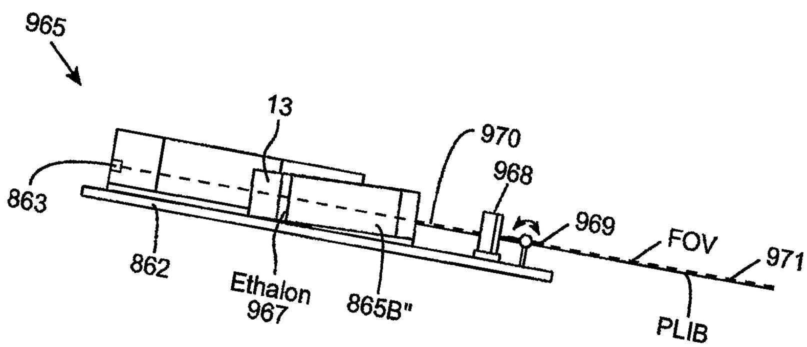


FIG. 1I25K2

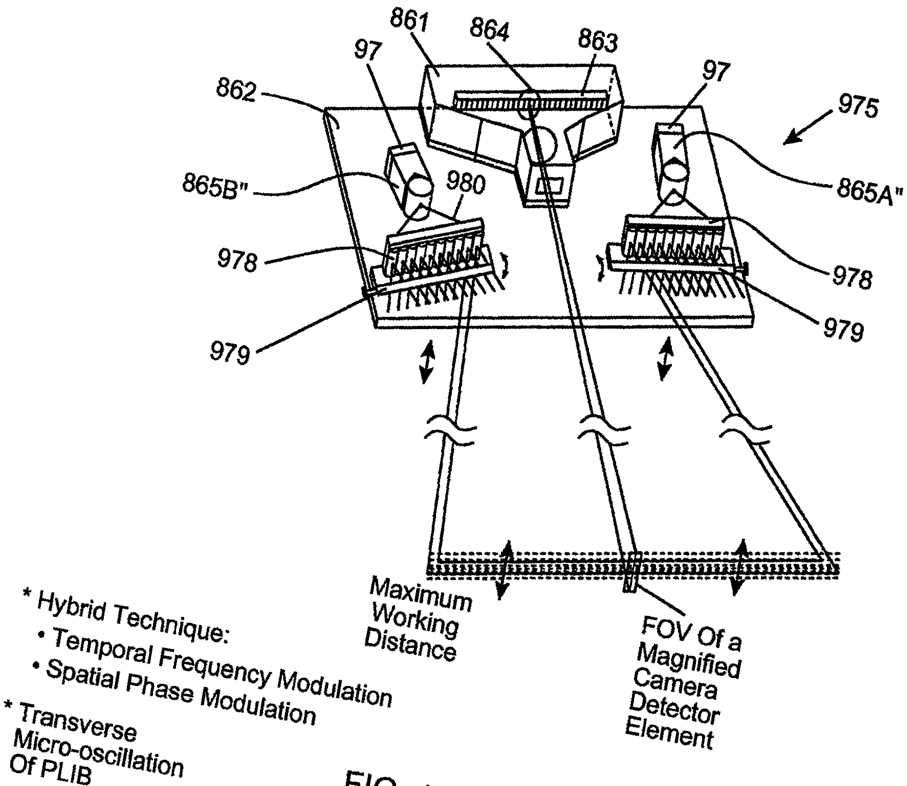


FIG. 1I25L1

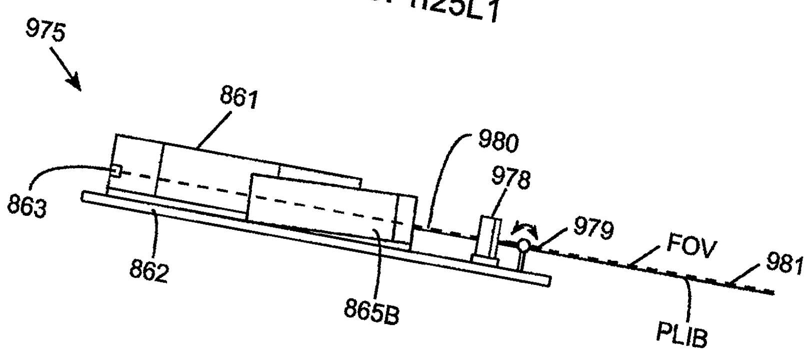


FIG. 1I25L2

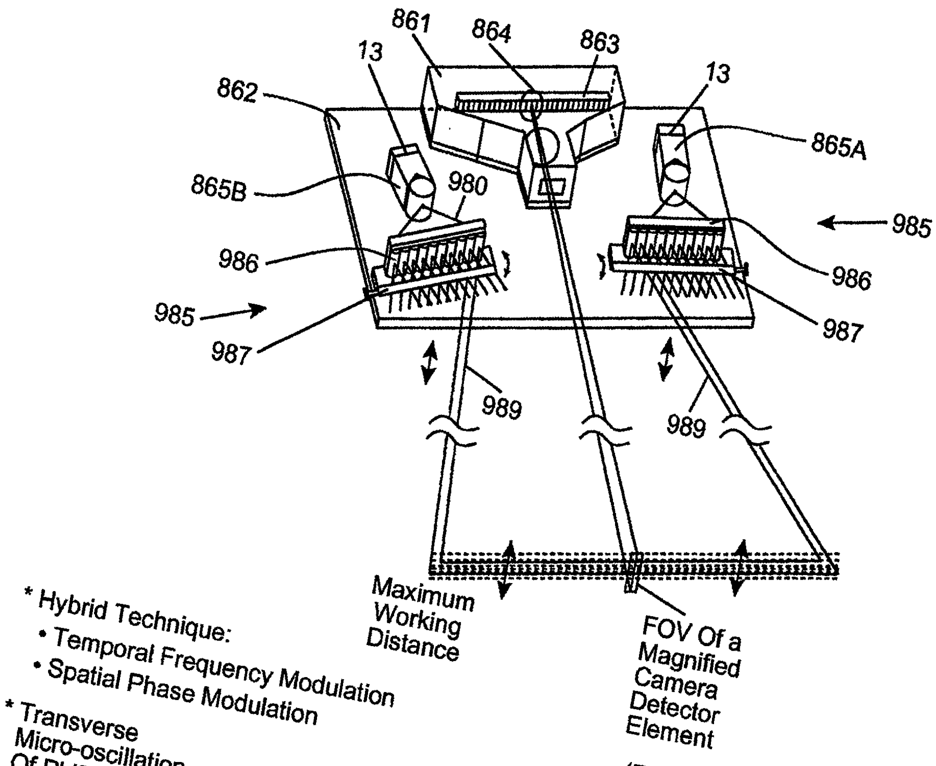


FIG. 1I25M1

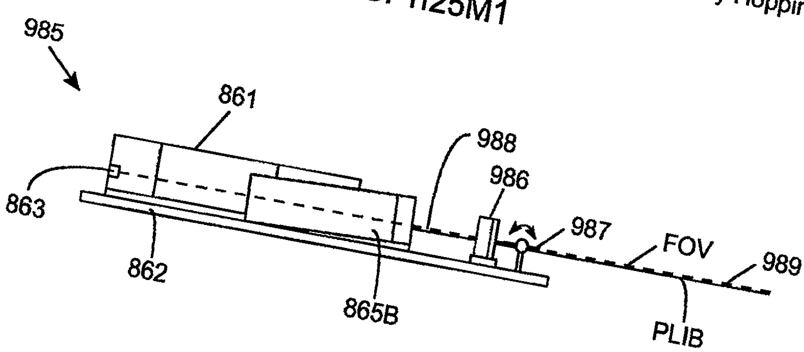


FIG. 1I25M2

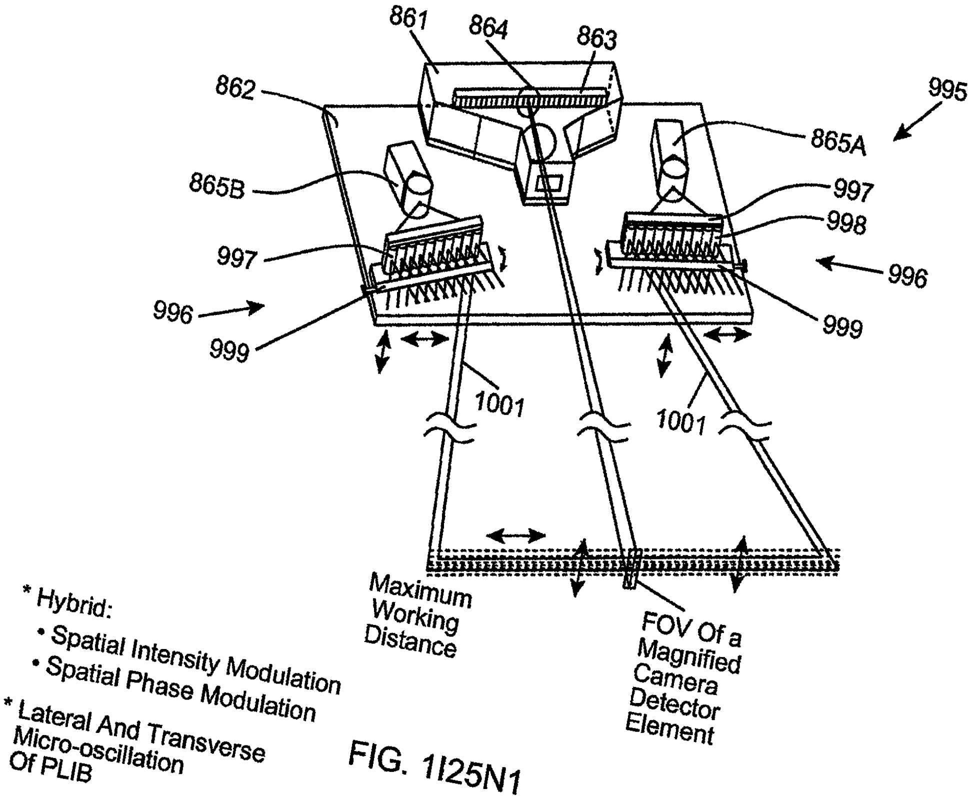


FIG. 1I25N1

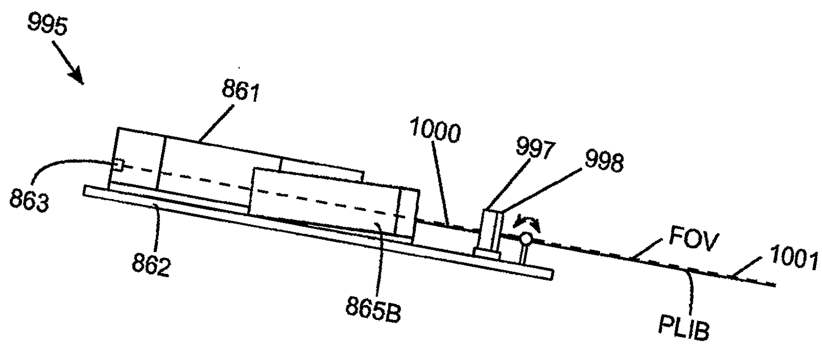


FIG. 1I25N2

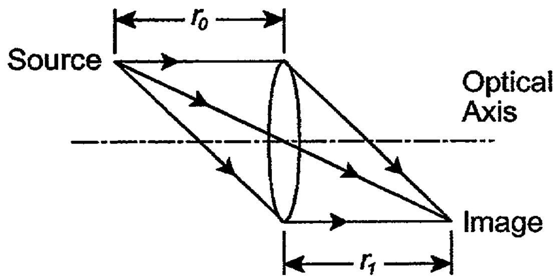


FIG. 1H1

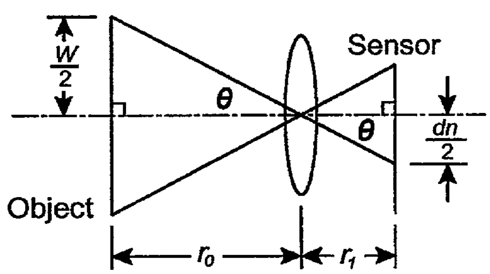


FIG. 1H2

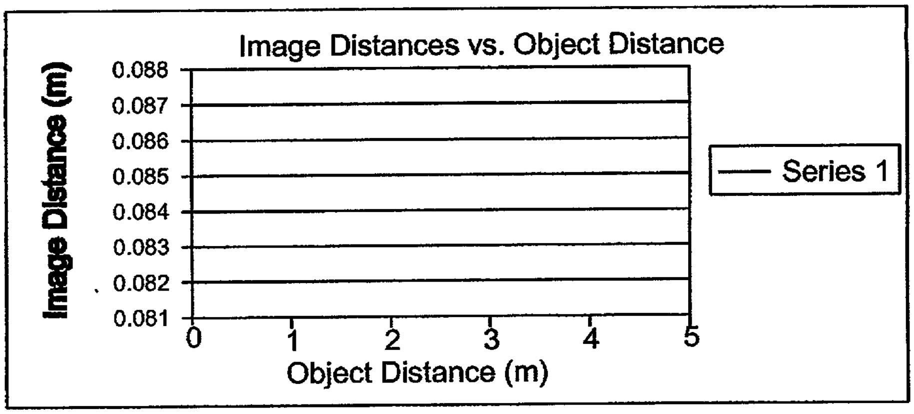


FIG. 1H3

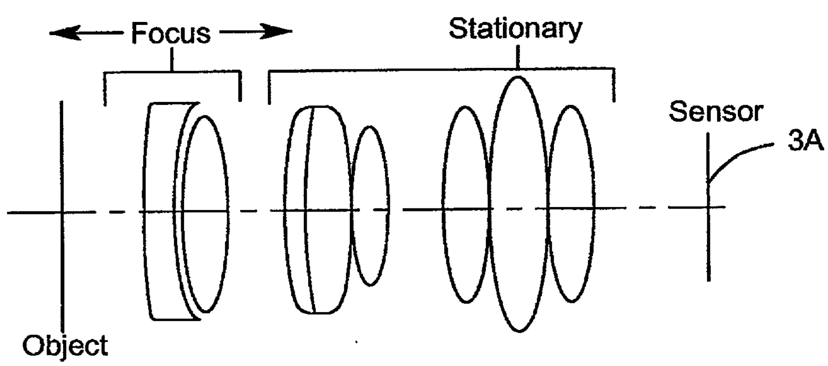


FIG. 1H4

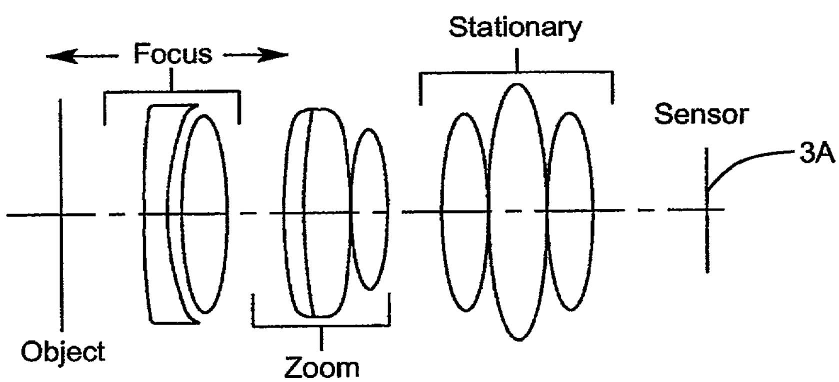


FIG. 1H5

Fixed Focal Length

Lens Cases

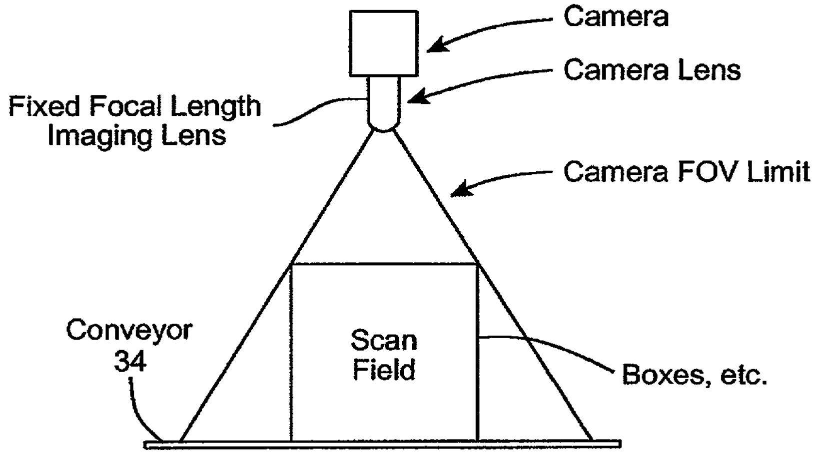


FIG. 1K1

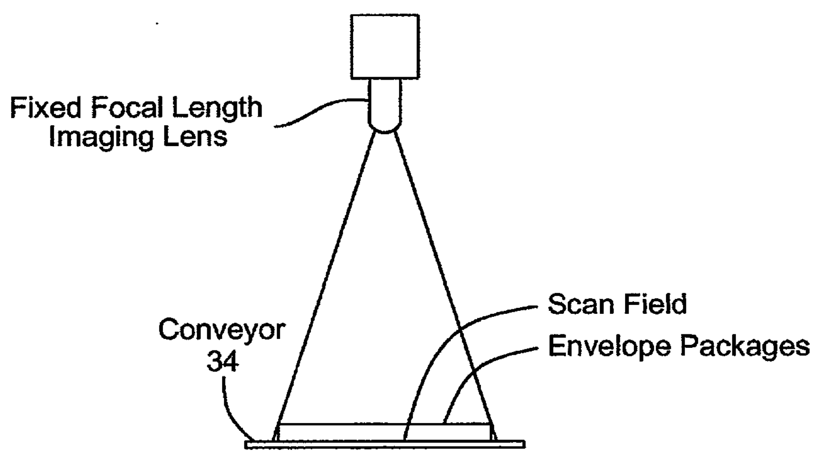


FIG. 1K2

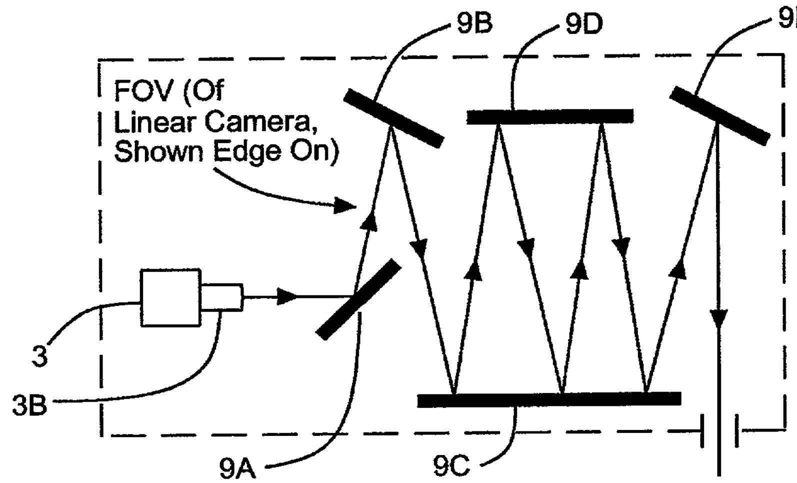


FIG. 1L1

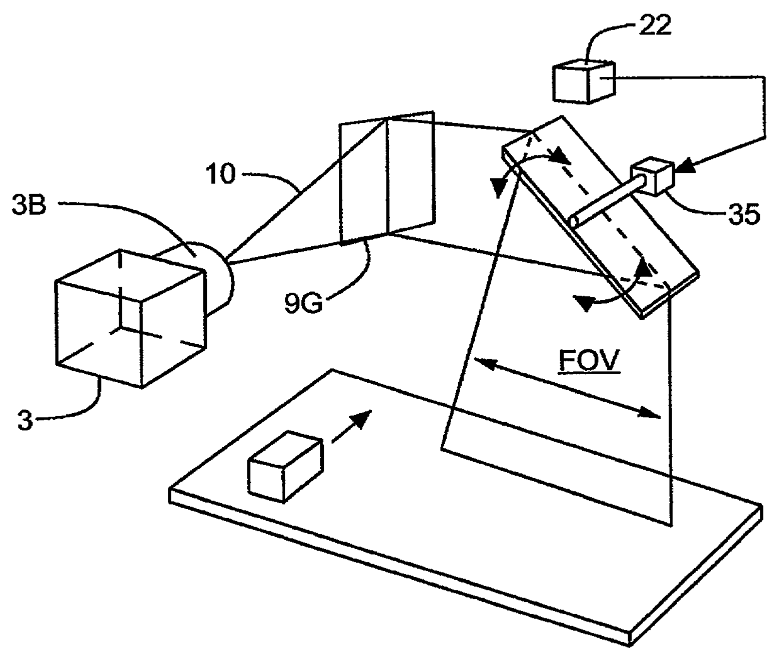


FIG. 1L2

Pixel Power Density vs. Object Distance (General Example)

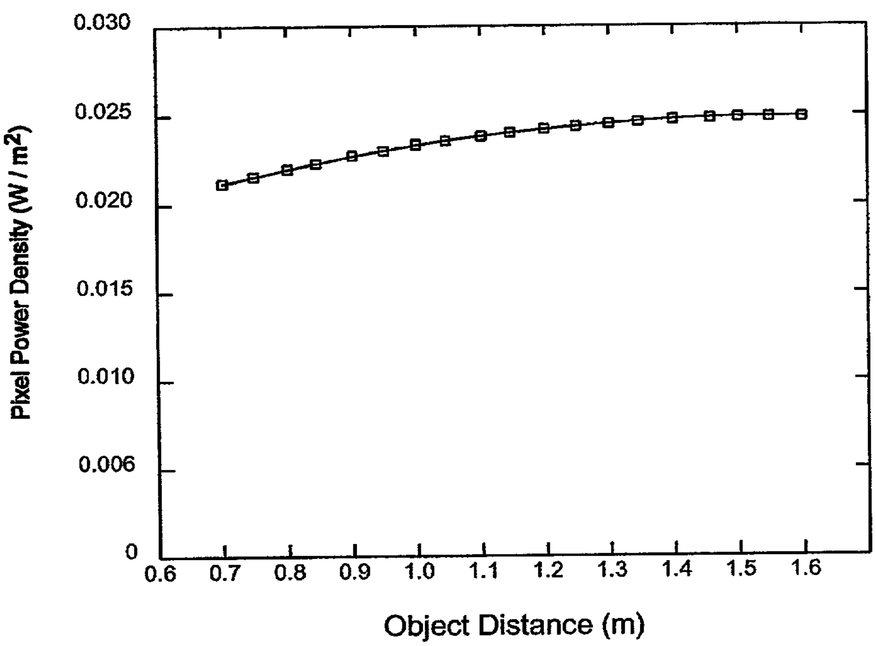


FIG. 1M1

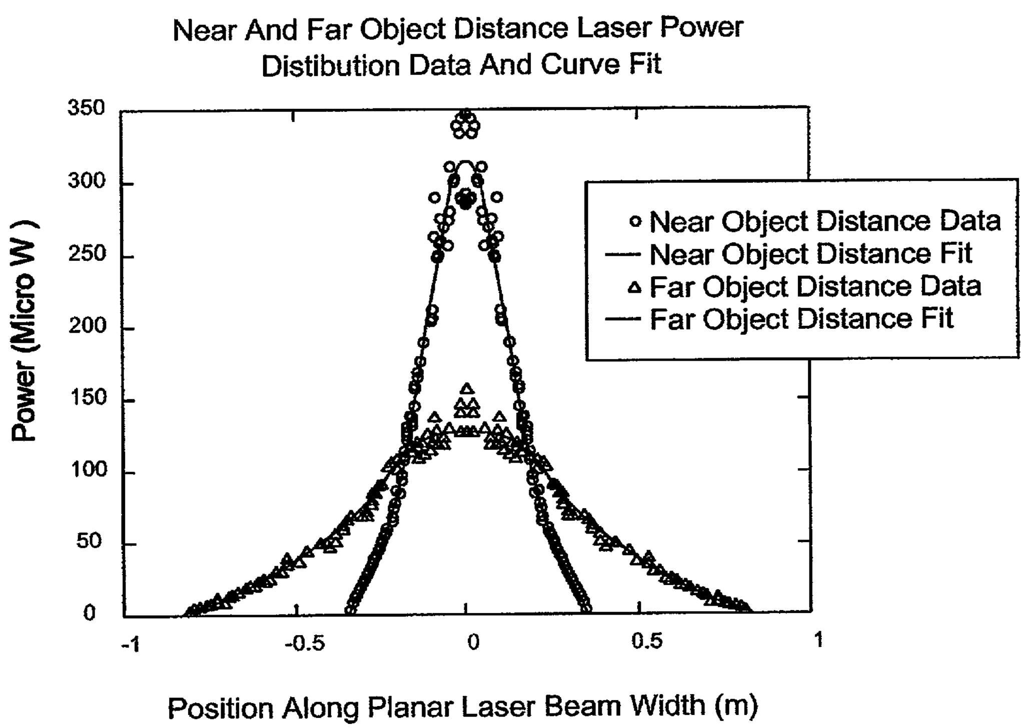

Near And Far Object Distance Laser Power
Distibution Data And Curve Fit
Power (Micro W)
350
300
250
200
150
100
50
0
-1
-0.5
0
0.5
1
Position Along Planar Laser Beam Width (m)
Near Object Distance Data
Near Object Distance Fit
Far Object Distance Data
Far Object Distance Fit

FIG. 1M2

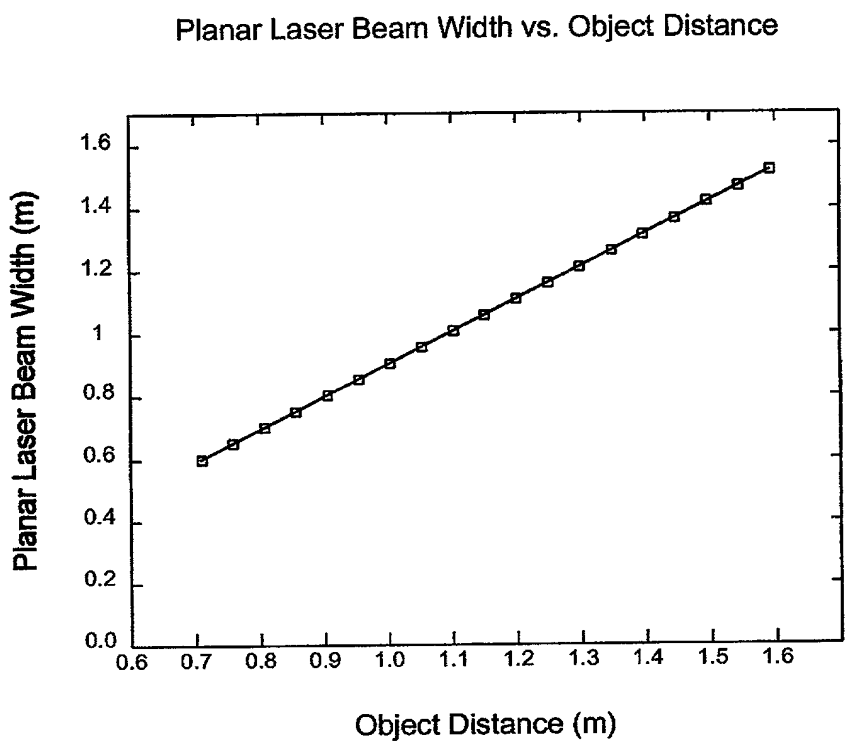

Planar Laser Beam Width vs. Object Distance
Planar Laser Beam Width (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0.0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Object Distance (m)

FIG. 1M3

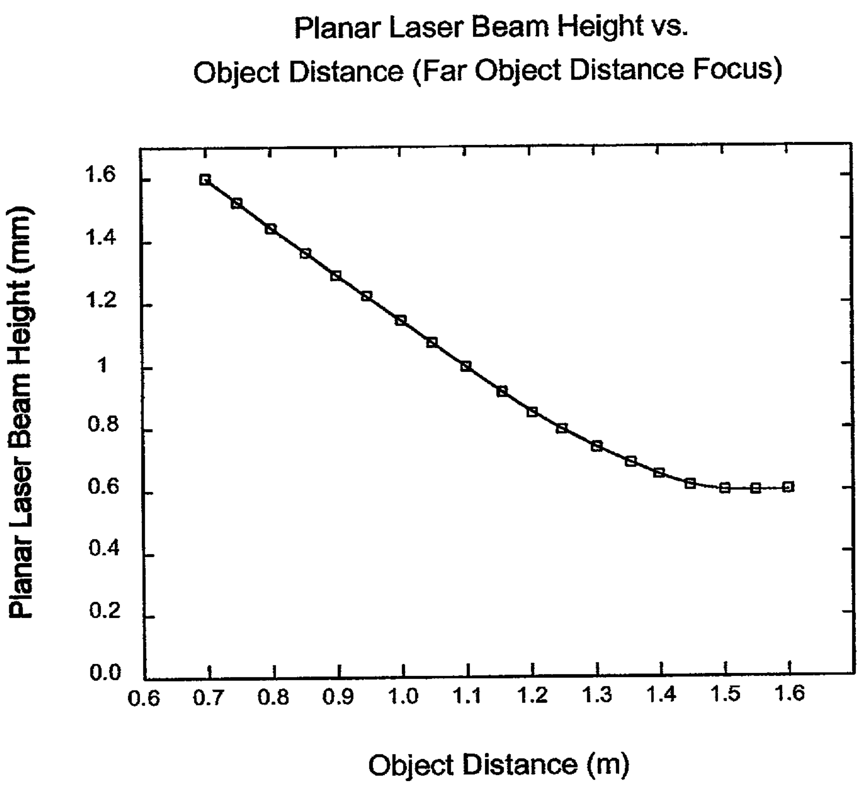

Planar Laser Beam Height vs.
Object Distance (Far Object Distance Focus)
Planar Laser Beam Height (mm)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0.0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Object Distance (m)

FIG. 1M4

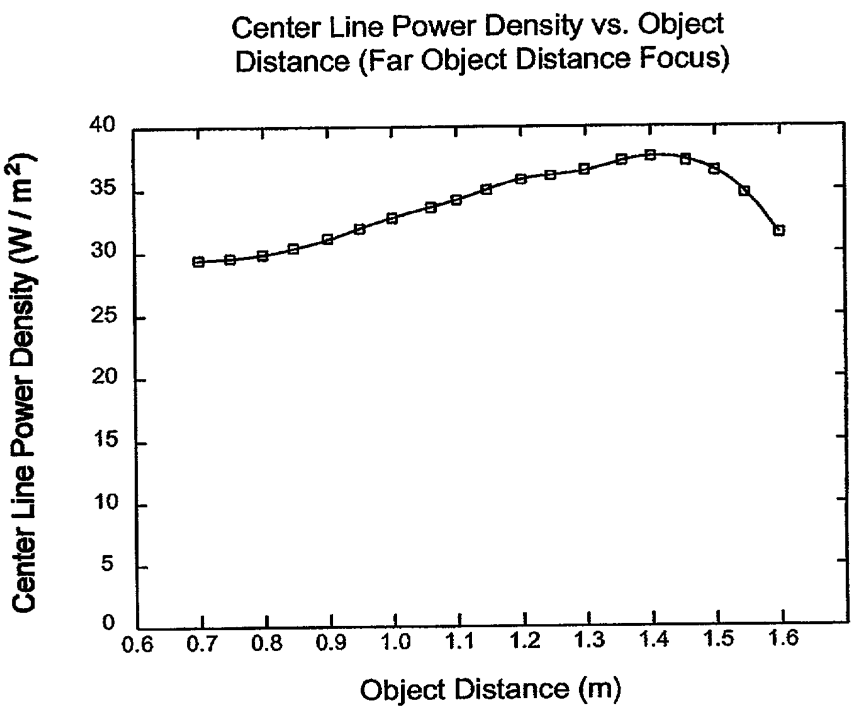

Center Line Power Density vs. Object Distance (Far Object Distance Focus)
Center Line Power Density (W / m^2)
40
35
30
25
20
15
10
5
0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Object Distance (m)

FIG. 1N

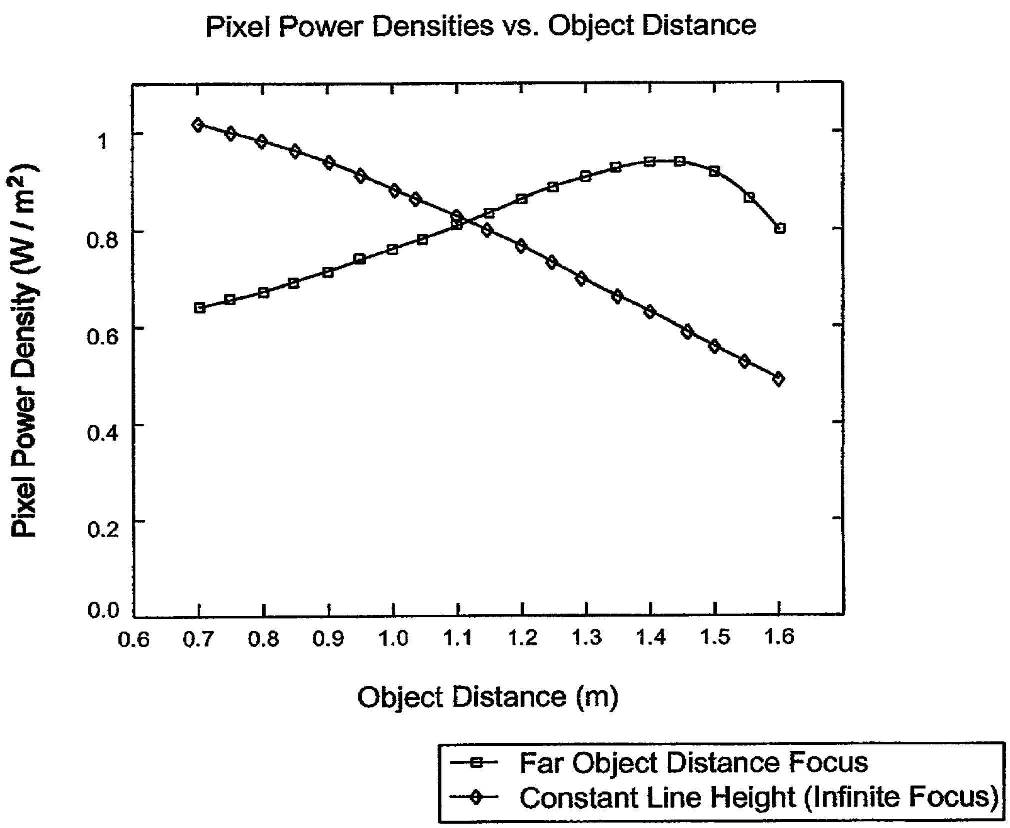

Pixel Power Densities vs. Object Distance
Pixel Power Density (W / m²)
1
0.8
0.6
0.4
0.2
0.0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Object Distance (m)
Far Object Distance Focus
Constant Line Height (Infinite Focus)

FIG. 10

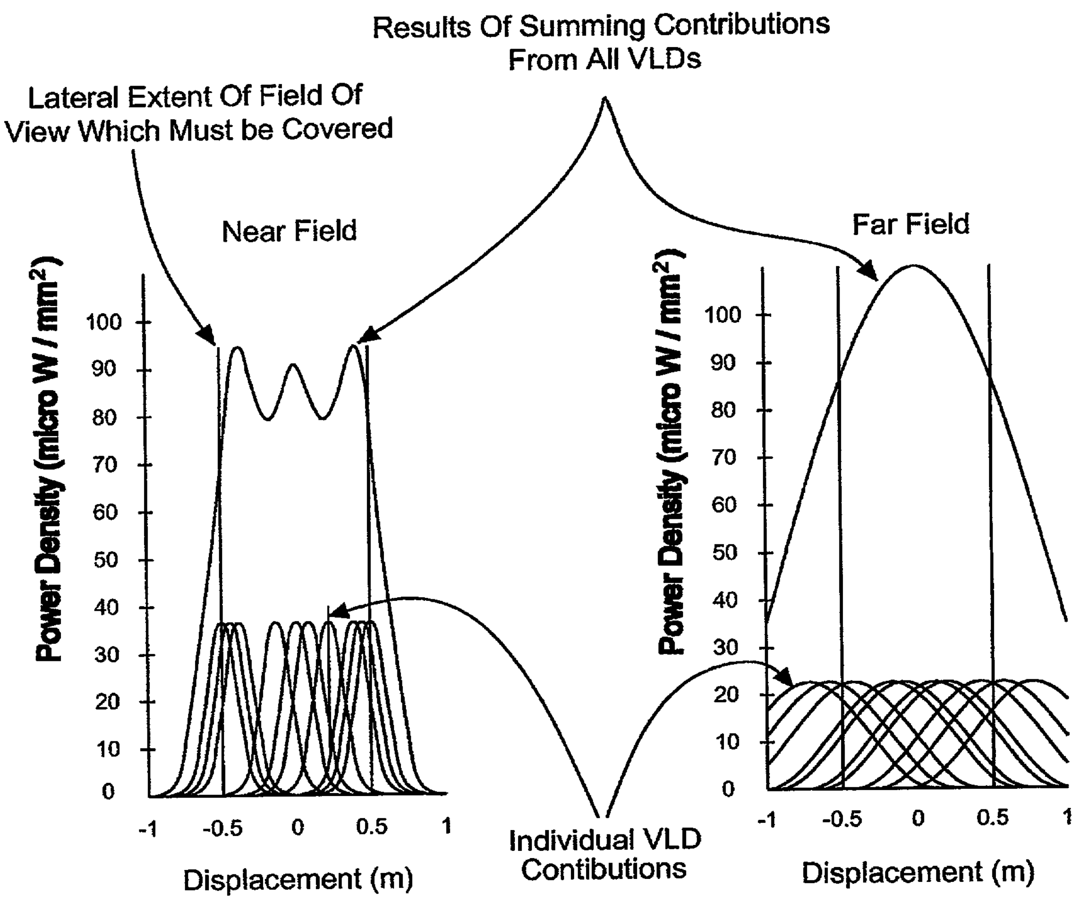


FIG. 1P1

FIG. 1P2

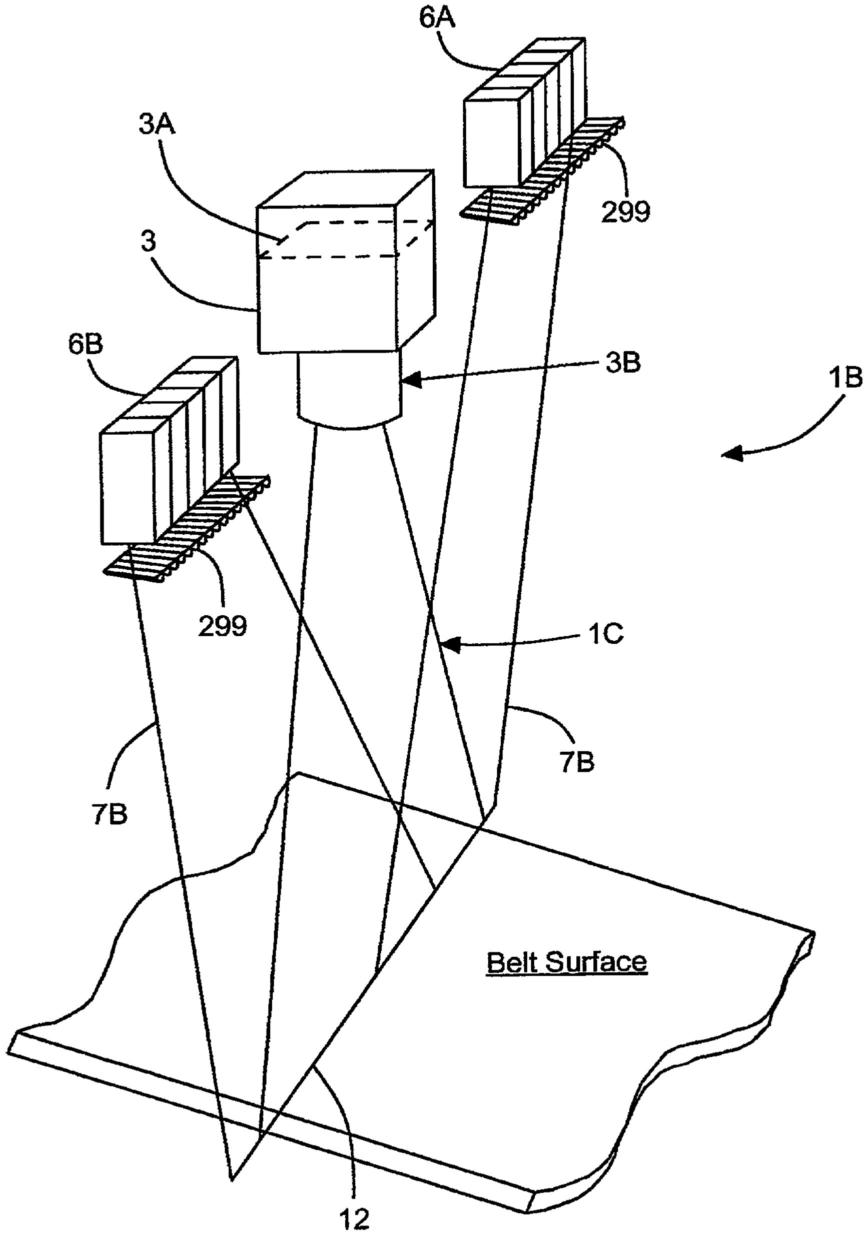


FIG. 1Q1

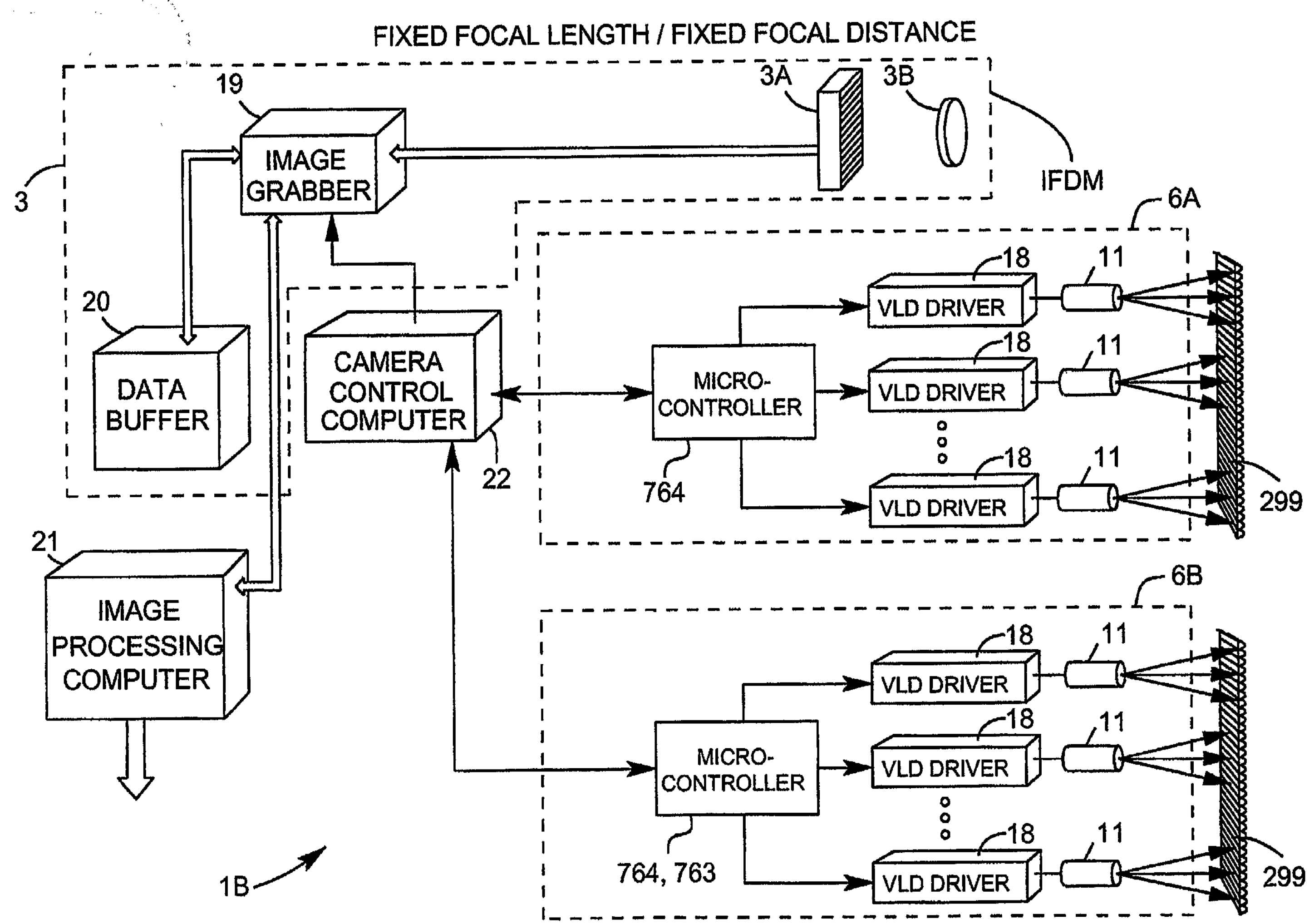

FIXED FOCAL LENGTH / FIXED FOCAL DISTANCE
3A
3B
IFDM
19
IMAGE GRABBER
3
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
6A
18
11
VLD DRIVER
MICRO-CONTROLLER
764
299
21
IMAGE PROCESSING COMPUTER
6B
764, 763
1B

FIG. 1Q2

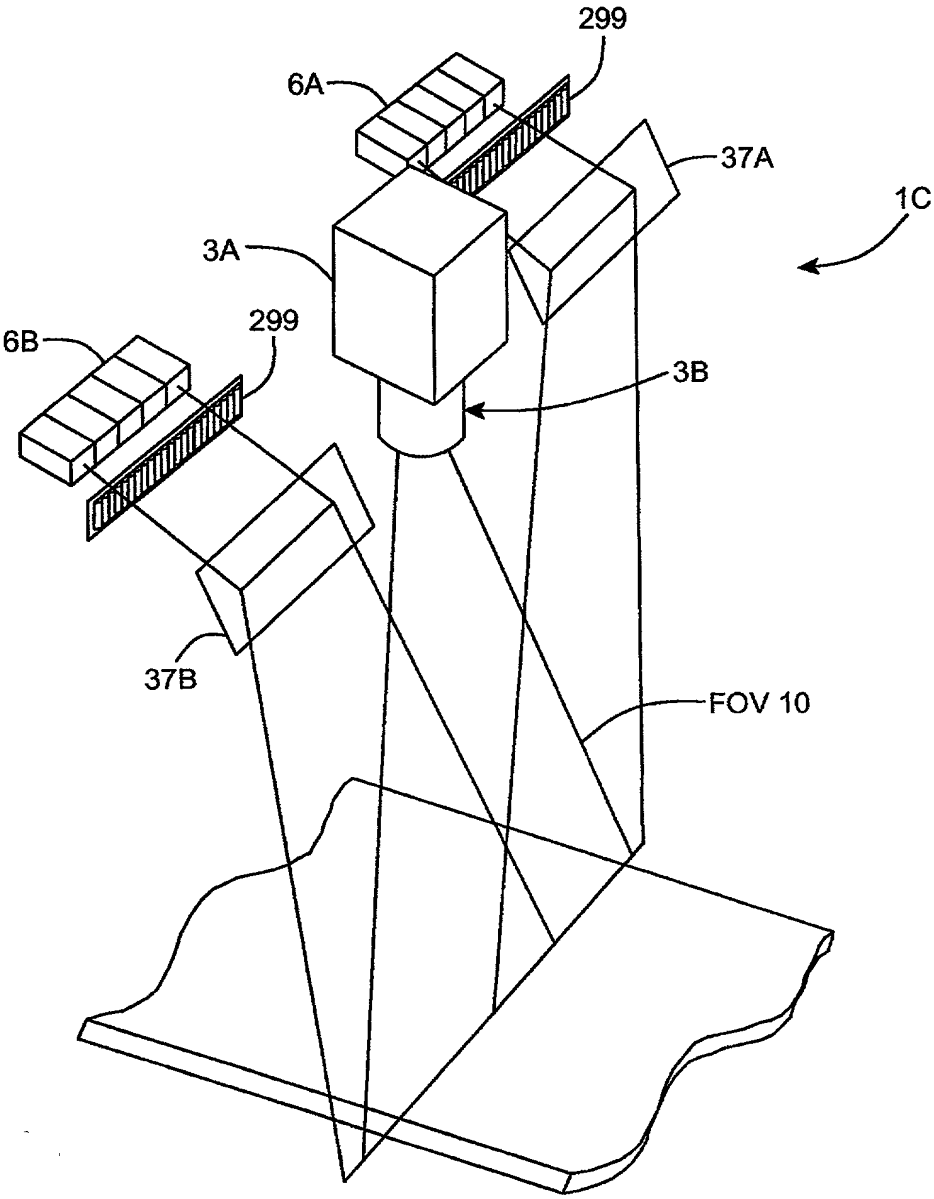


FIG. 1R1

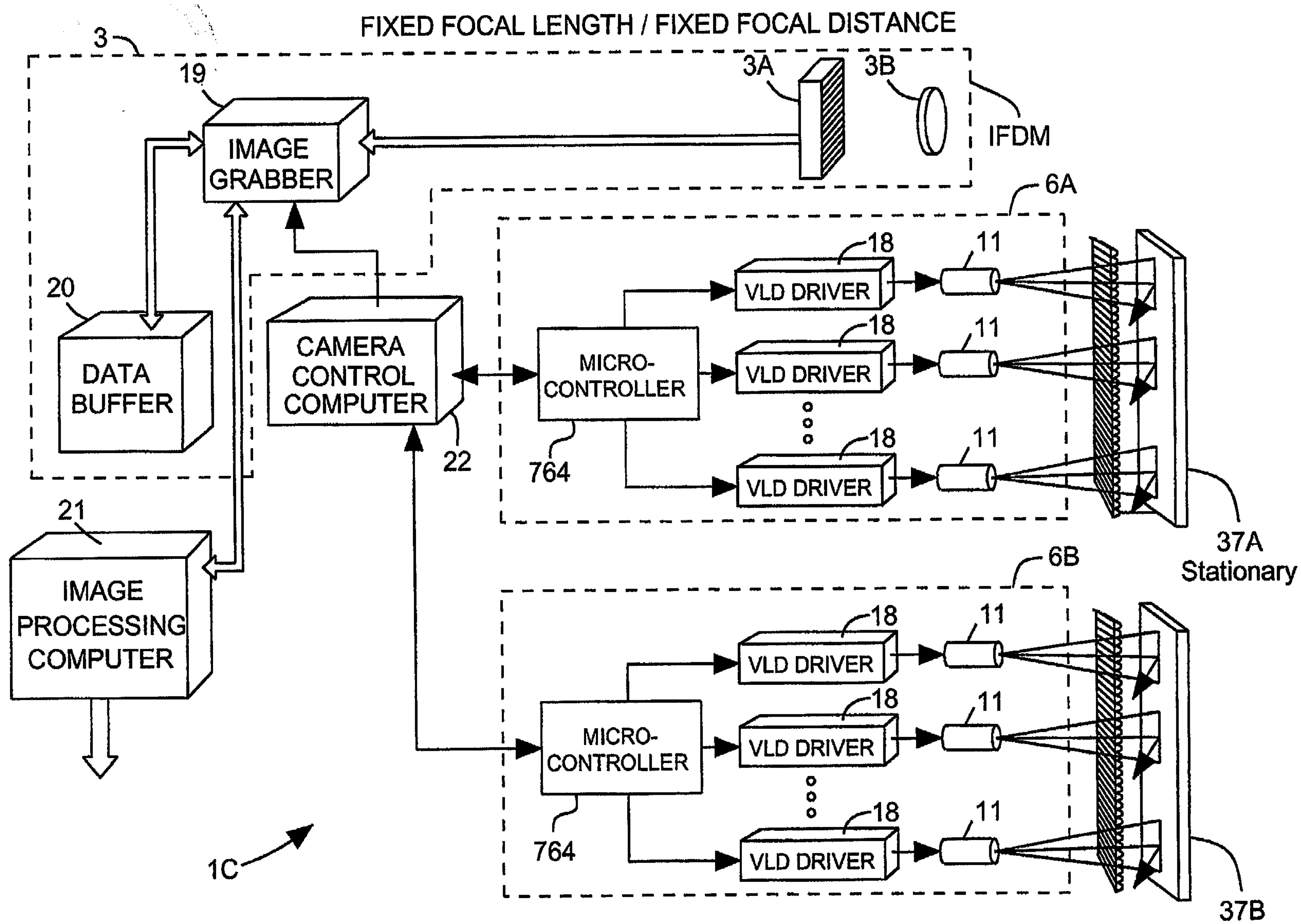

FIXED FOCAL LENGTH / FIXED FOCAL DISTANCE
3
19
IMAGE GRABBER
3A
3B
IFDM
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
21
IMAGE PROCESSING COMPUTER
6A
6B
MICRO-CONTROLLER
764
VLD DRIVER
18
11
37A Stationary
37B Stationary
1C

FIG. 1R2

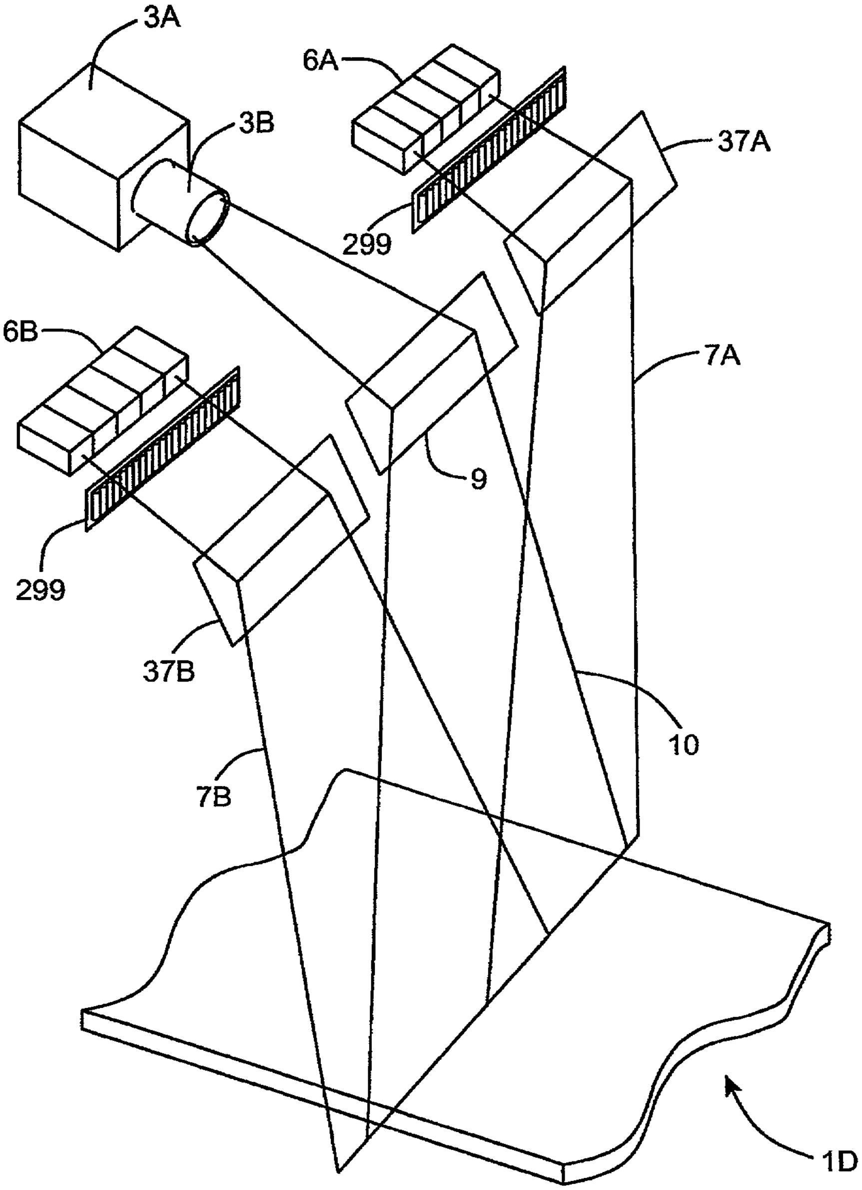


FIG. 1S1

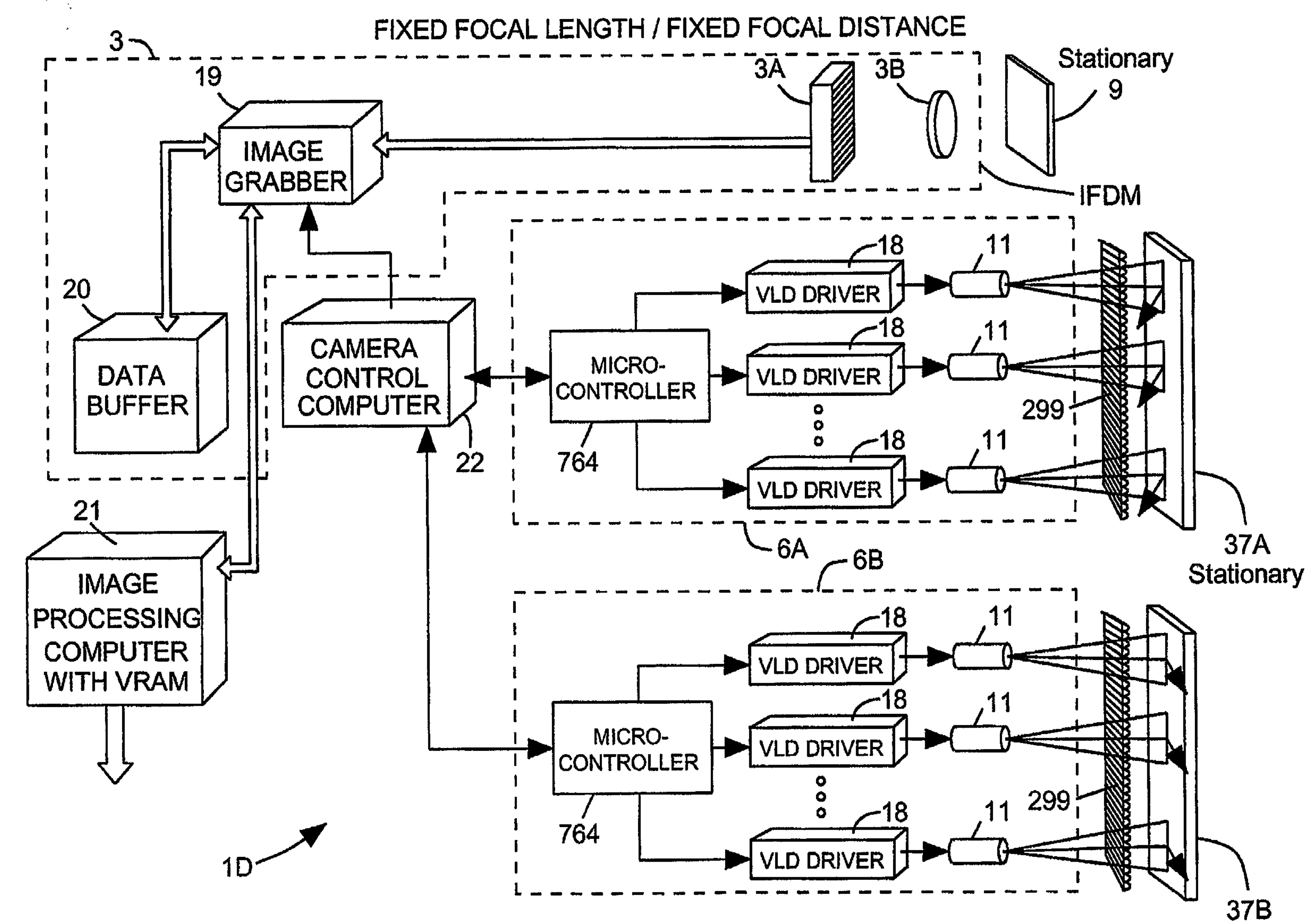

FIXED FOCAL LENGTH / FIXED FOCAL DISTANCE
3
19
IMAGE GRABBER
3A
3B
Stationary
9
IFDM
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
764
VLD DRIVER
18
11
299
6A
37A
Stationary
6B
37B
Stationary
21
IMAGE PROCESSING COMPUTER WITH VRAM
1D

FIG. 1S2

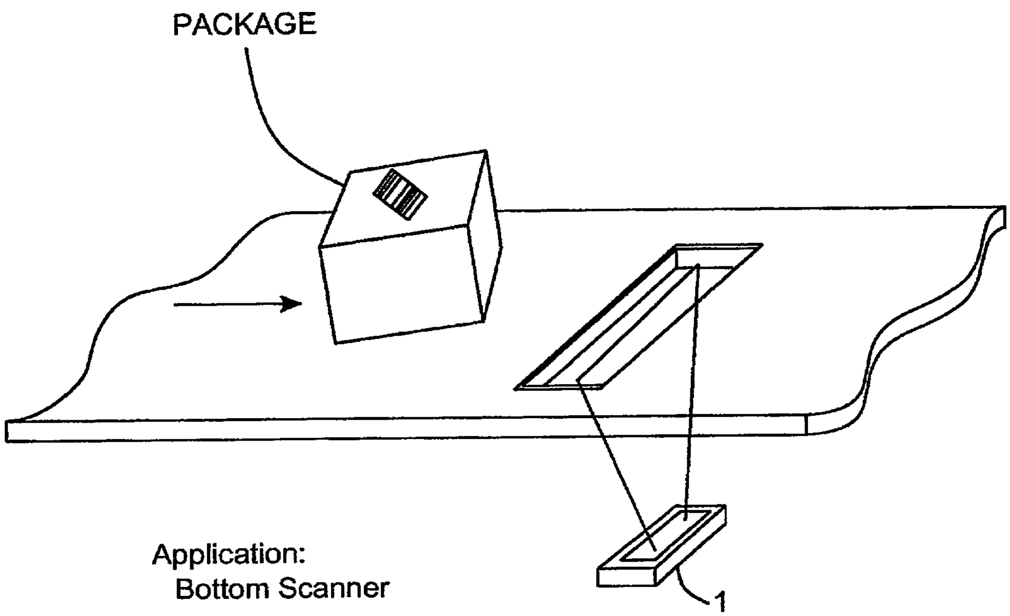


FIG. 1T

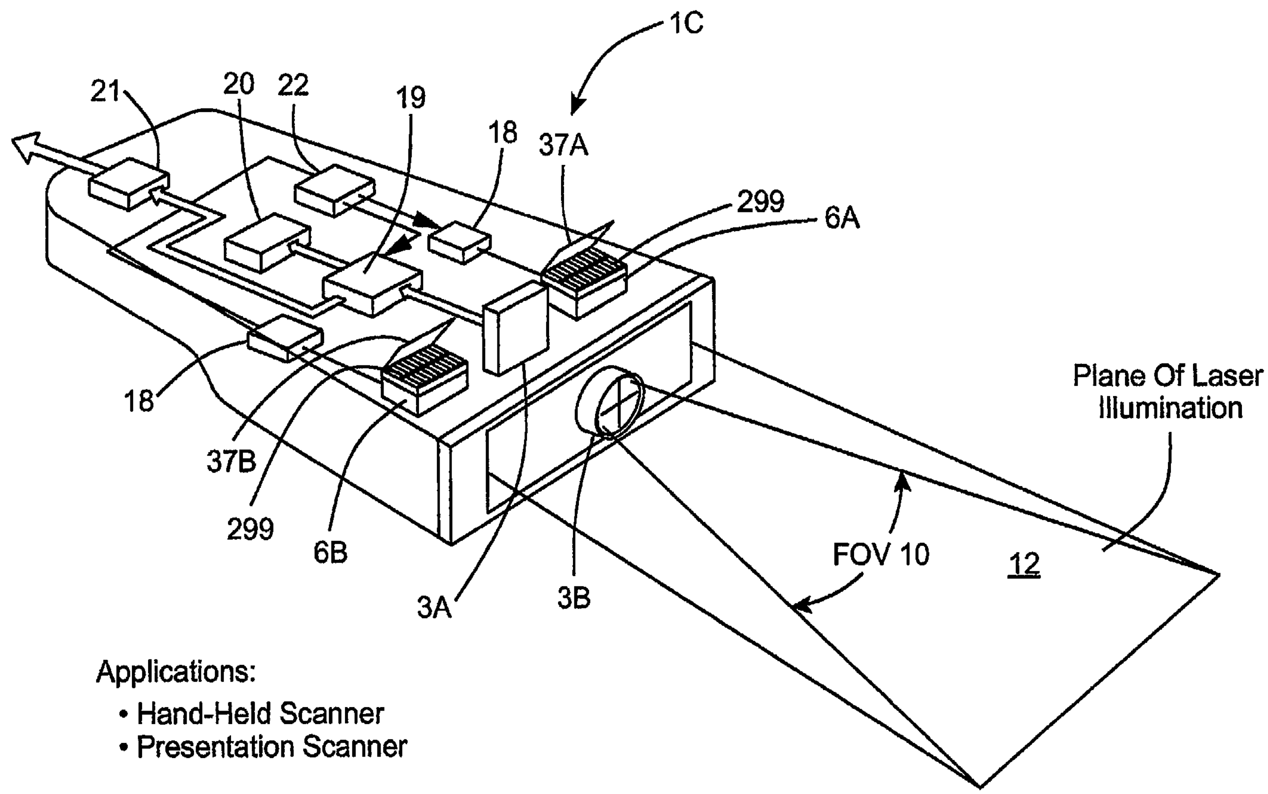

1C
21
20
22
19
18
37A
299
6A
18
37B
299
6B
3A
3B
FOV 10
12
Plane Of Laser Illumination
Applications:
• Hand-Held Scanner
• Presentation Scanner

FIG. 1U

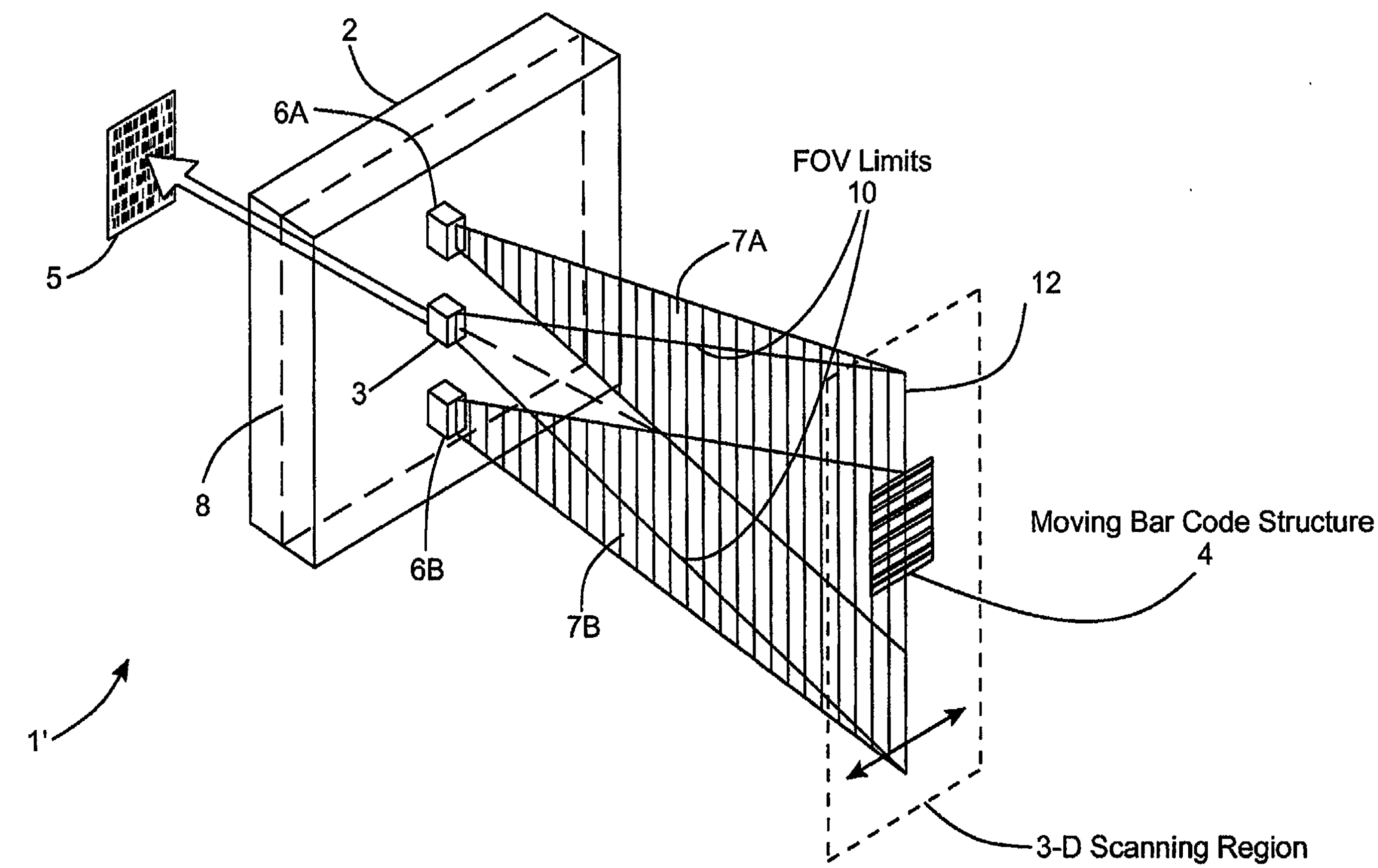

2
6A
5
FOV Limits
10
7A
12
3
8
6B
7B
Moving Bar Code Structure
4
1'
3-D Scanning Region

FIG. 1V1

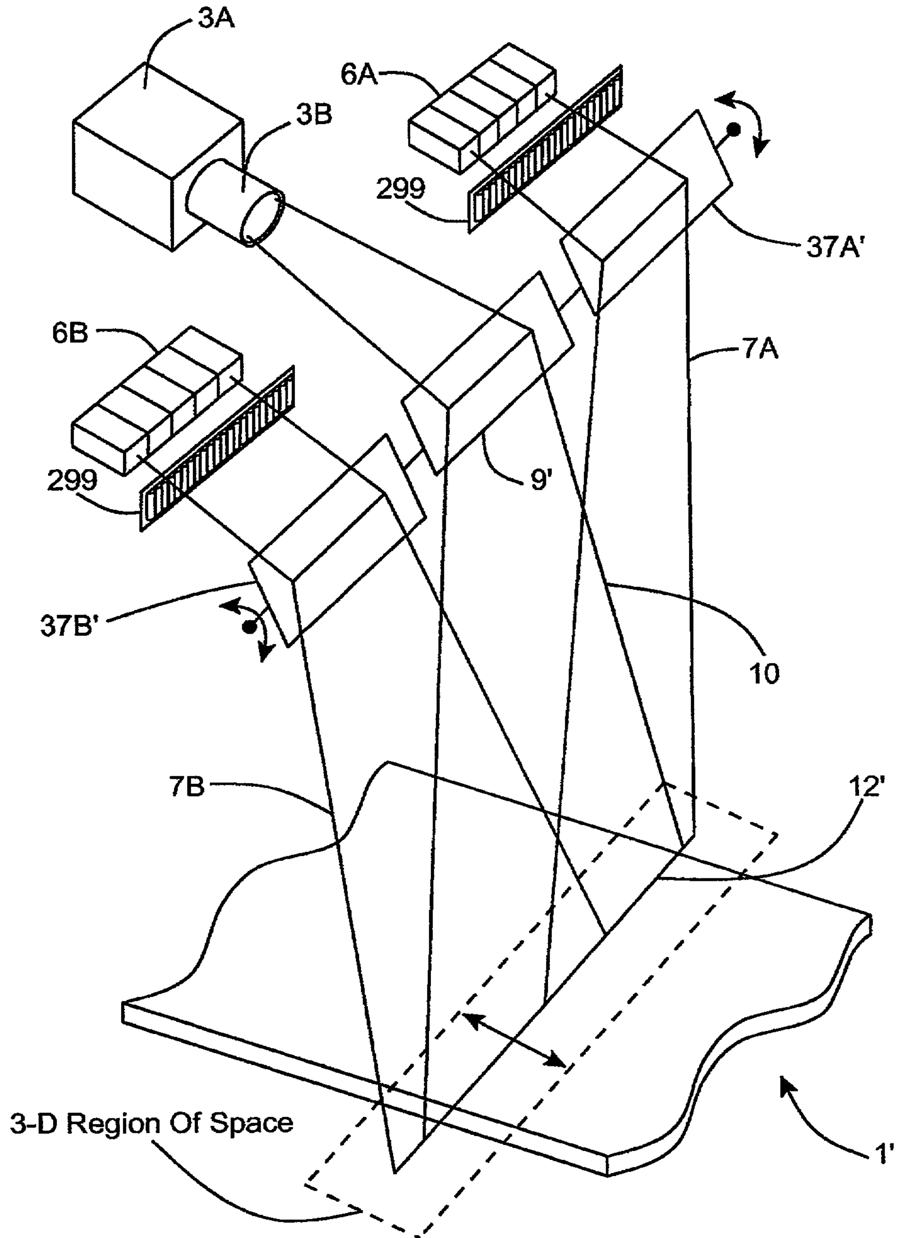


FIG. 1V2

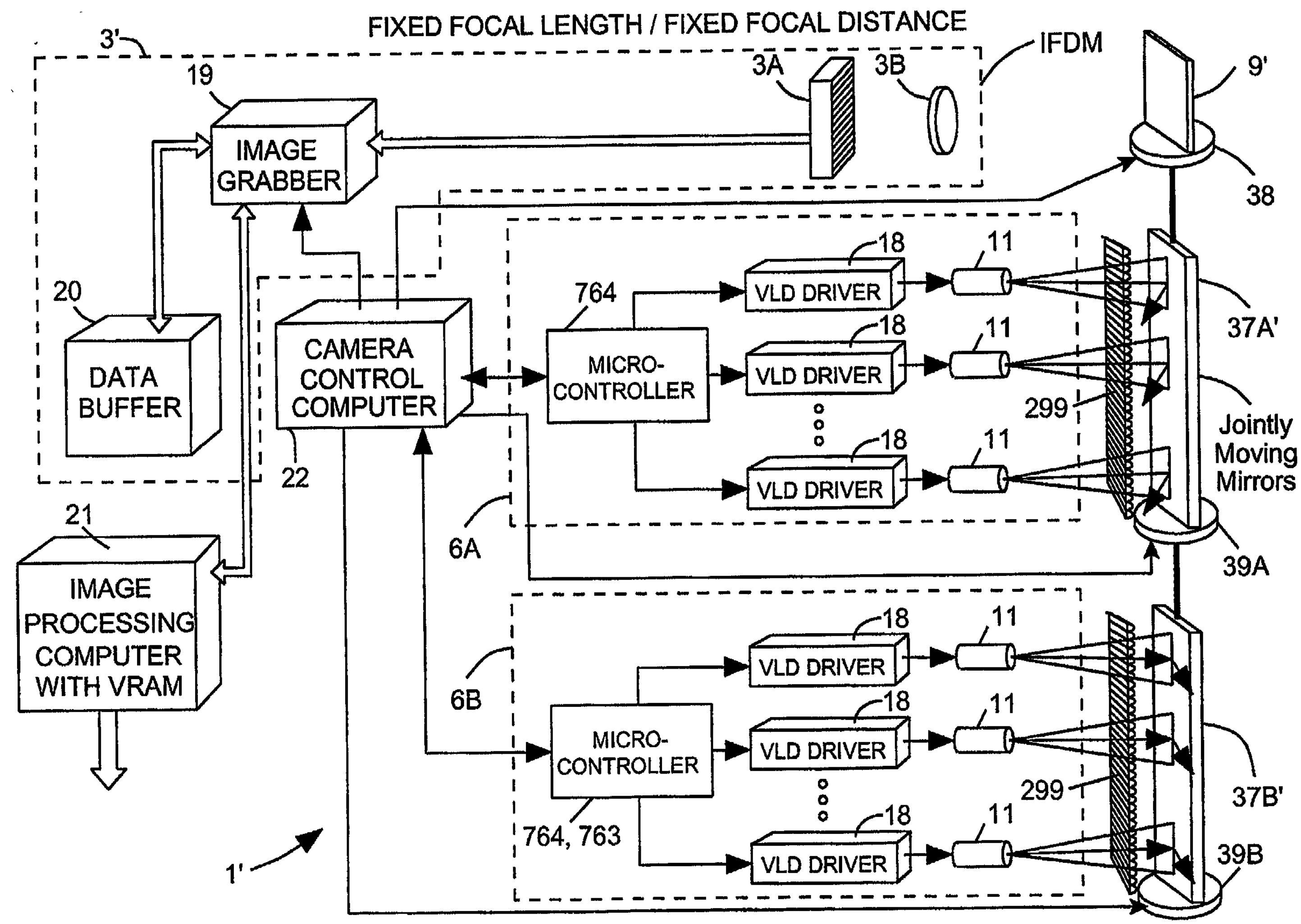

FIXED FOCAL LENGTH / FIXED FOCAL DISTANCE
3'
IFDM
19
IMAGE GRABBER
3A
3B
9'
38
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
764
MICRO-CONTROLLER
18
VLD DRIVER
11
37A'
299
Jointly Moving Mirrors
39A
6A
21
IMAGE PROCESSING COMPUTER WITH VRAM
6B
764, 763
37B'
39B
1'

FIG. 1V3

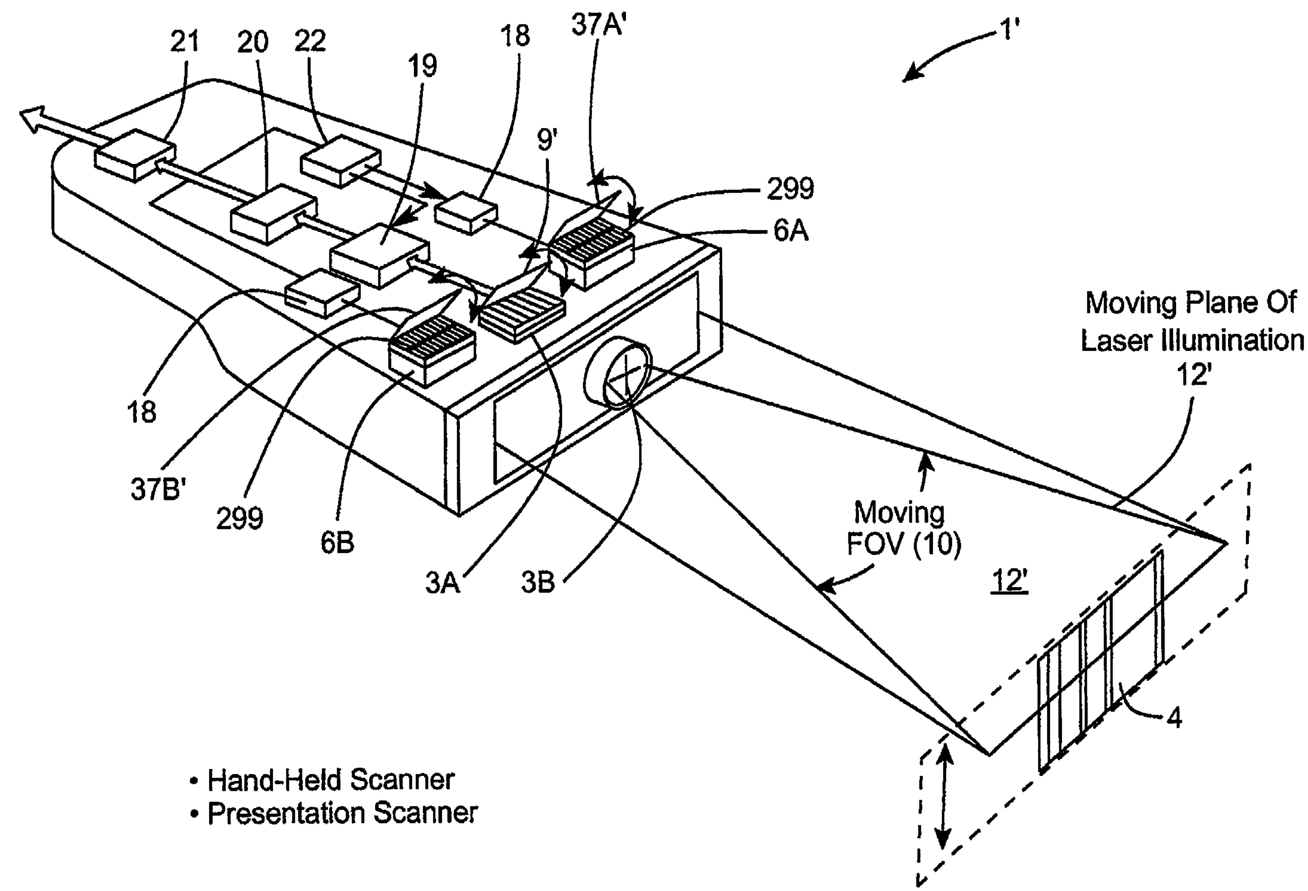
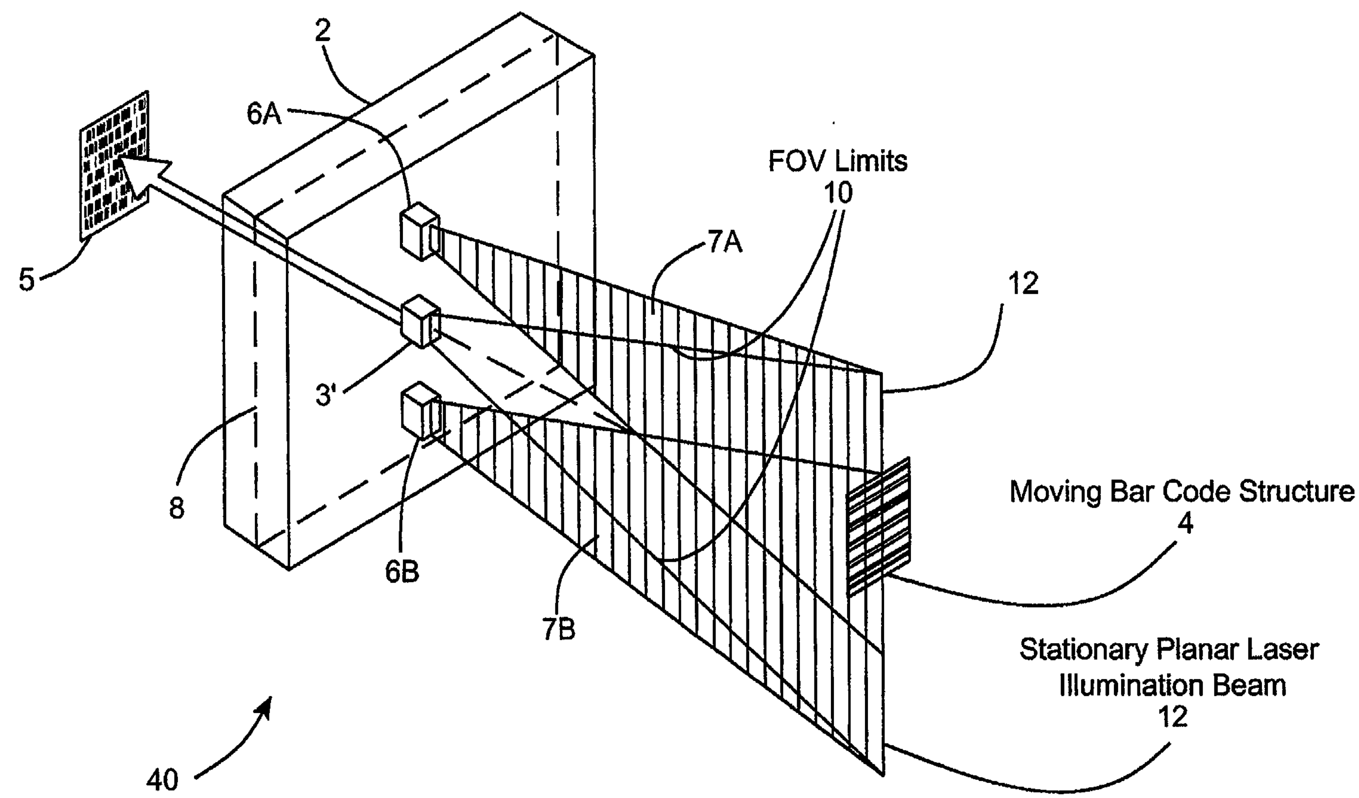

1'
21
20
22
19
18
37A'
9'
299
6A
18
37B'
299
6B
3A
3B
Moving Plane Of
Laser Illumination
12'
Moving
FOV (10)
12'
4
• Hand-Held Scanner
• Presentation Scanner

FIG. 1V4



2
6A
FOV Limits
10
7A
5
12
3'
8
6B
Moving Bar Code Structure
4
7B
Stationary Planar Laser
Illumination Beam
12
40

FIG. 2A

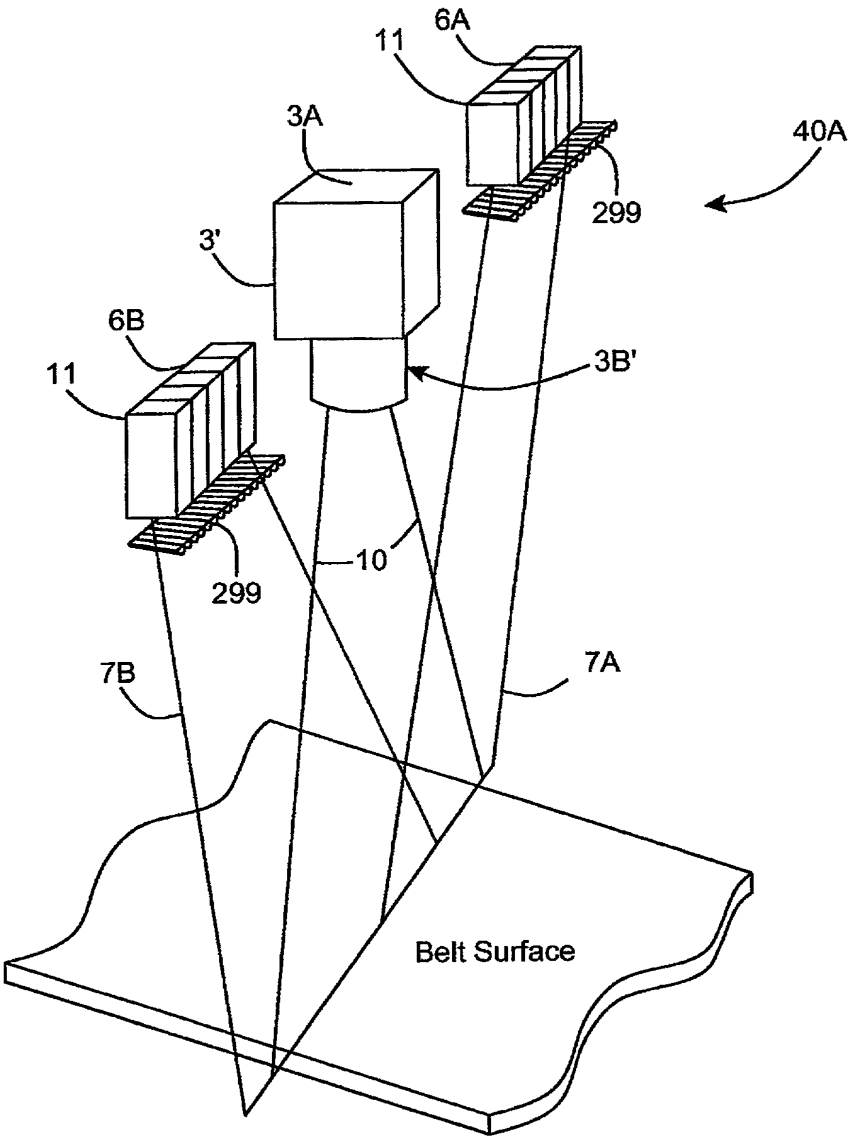


FIG. 2B1

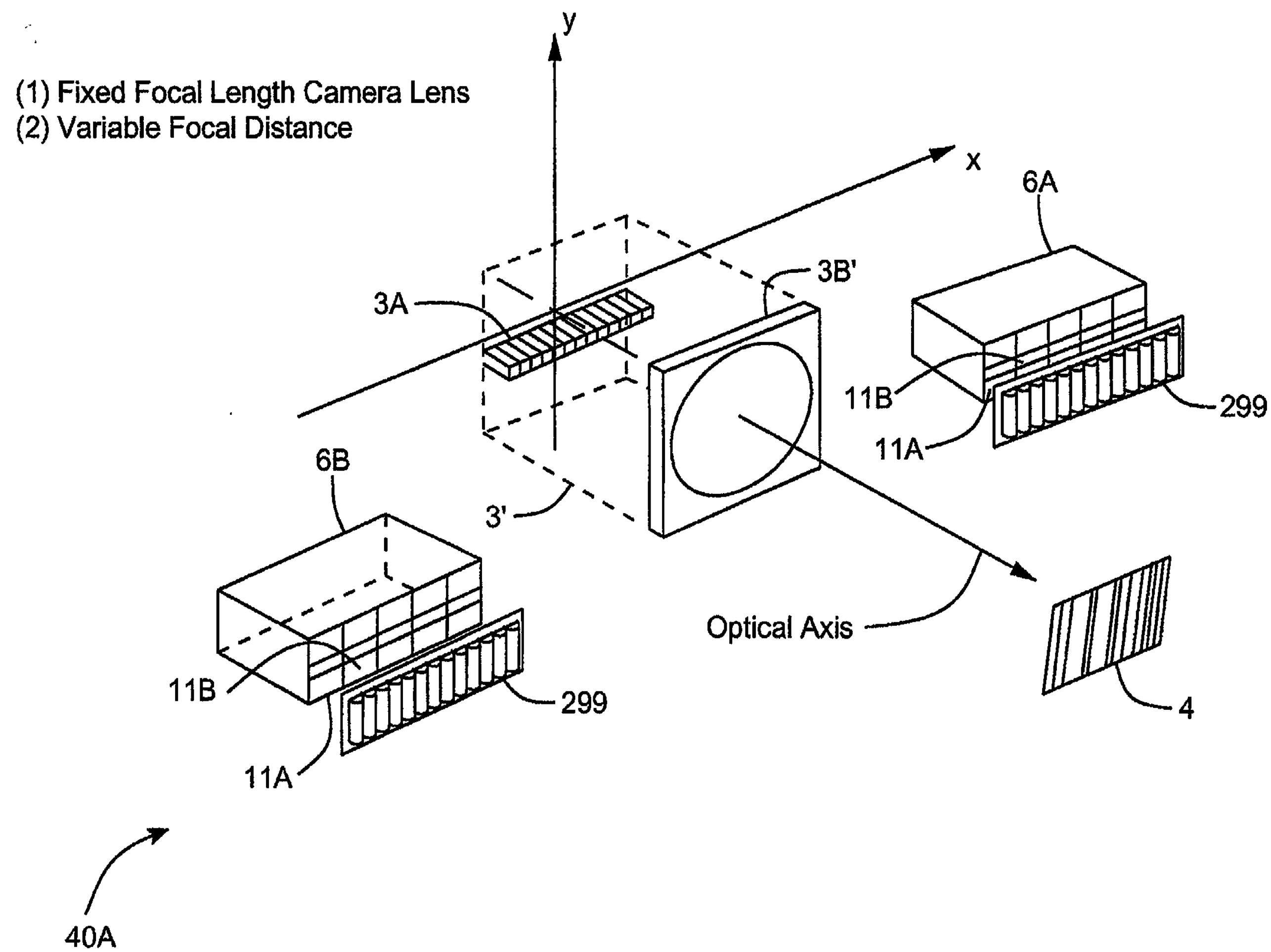
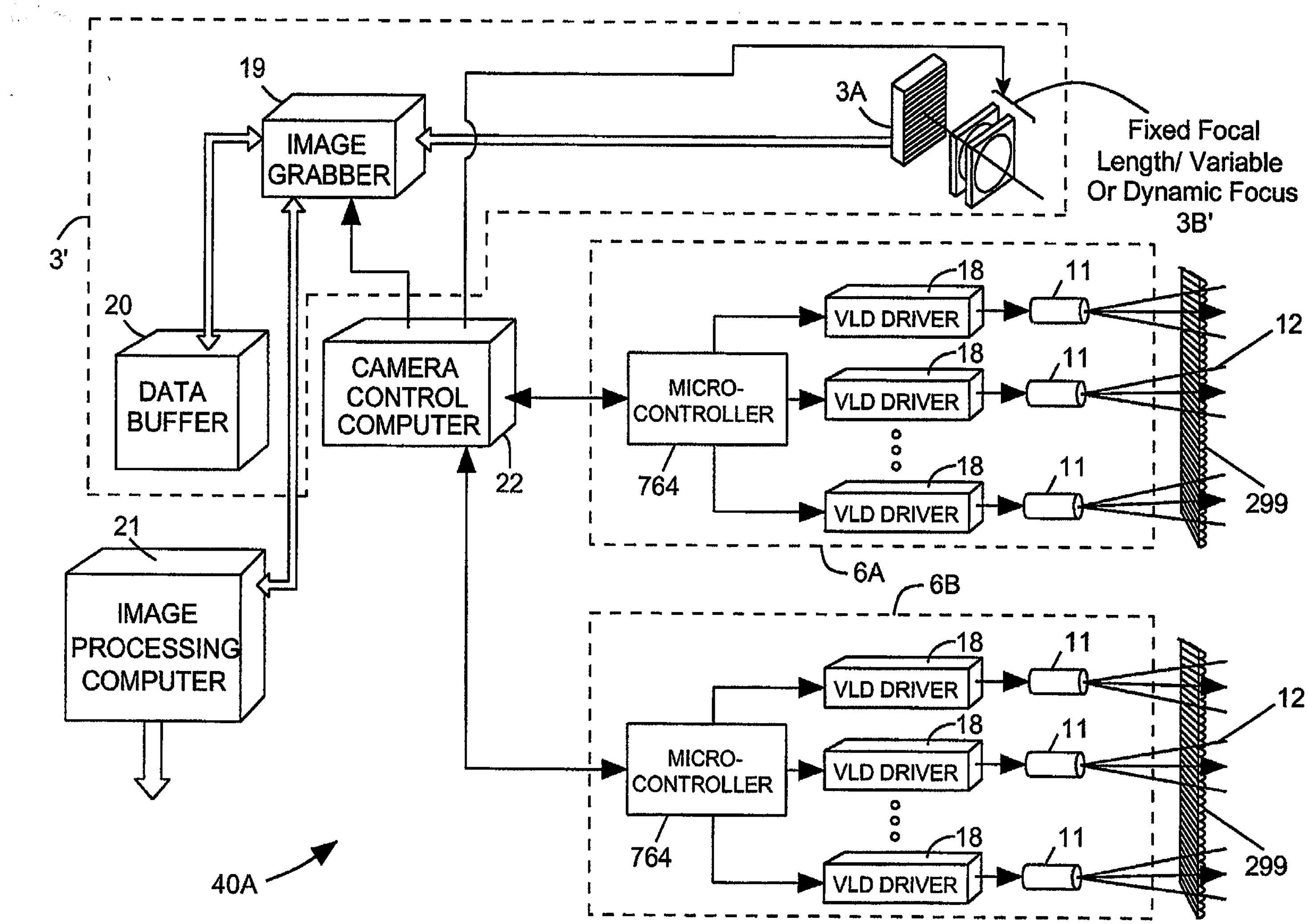

(1) Fixed Focal Length Camera Lens
(2) Variable Focal Distance
y
x
6A
3B'
3A
11B
299
11A
6B
3'
Optical Axis
11B
299
4
11A
40A

FIG. 2B2



19
IMAGE GRABBER
3A
Fixed Focal Length/ Variable Or Dynamic Focus 3B'
3'
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
764
VLD DRIVER
18
11
12
299
6A
6B
21
IMAGE PROCESSING COMPUTER
40A

FIG. 2C1

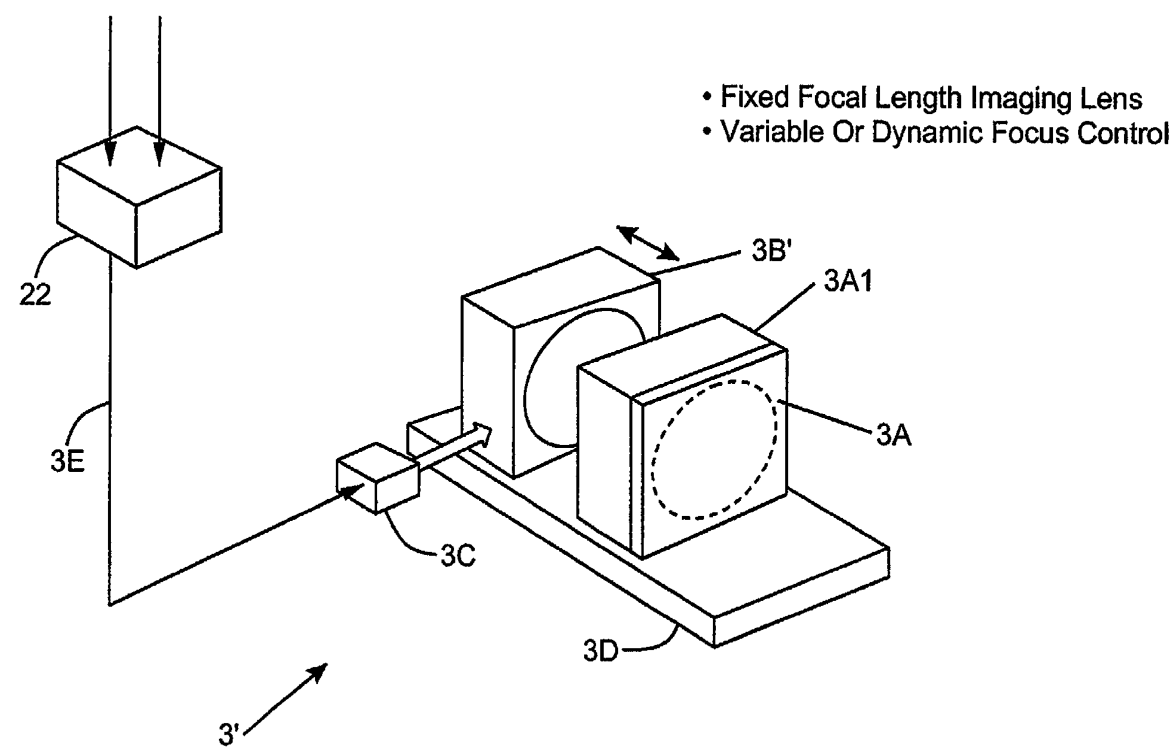

• Fixed Focal Length Imaging Lens
• Variable Or Dynamic Focus Control
22
3E
3C
3B'
3A1
3A
3D
3'

FIG. 2C2

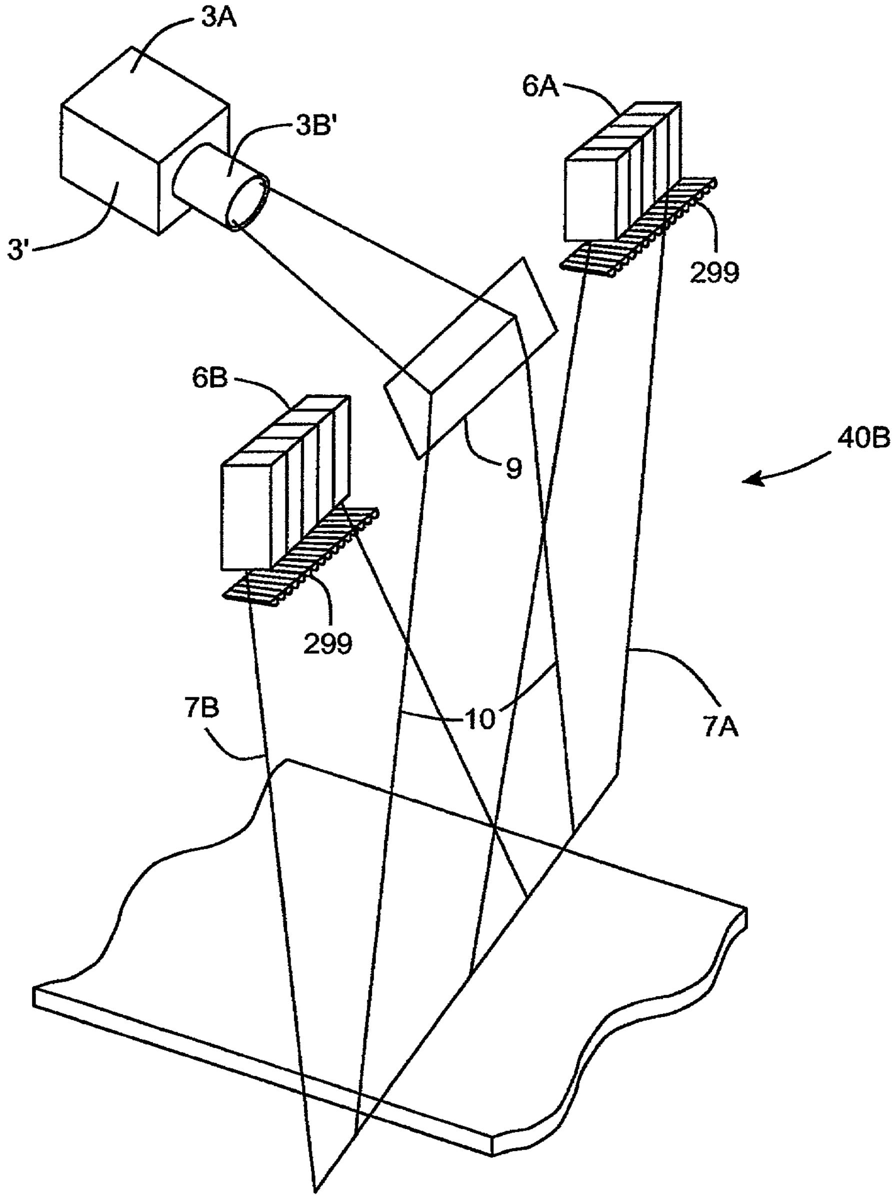
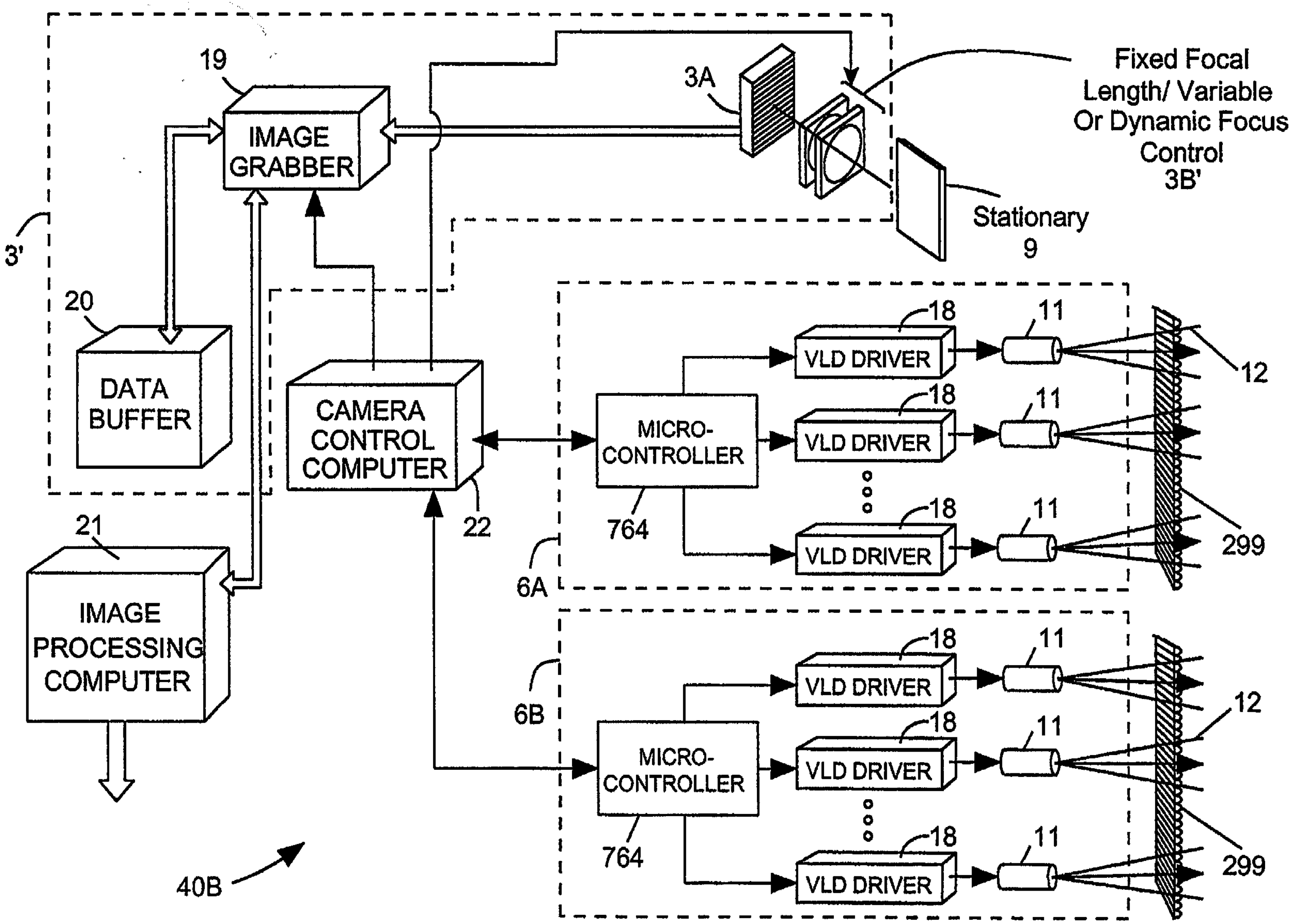
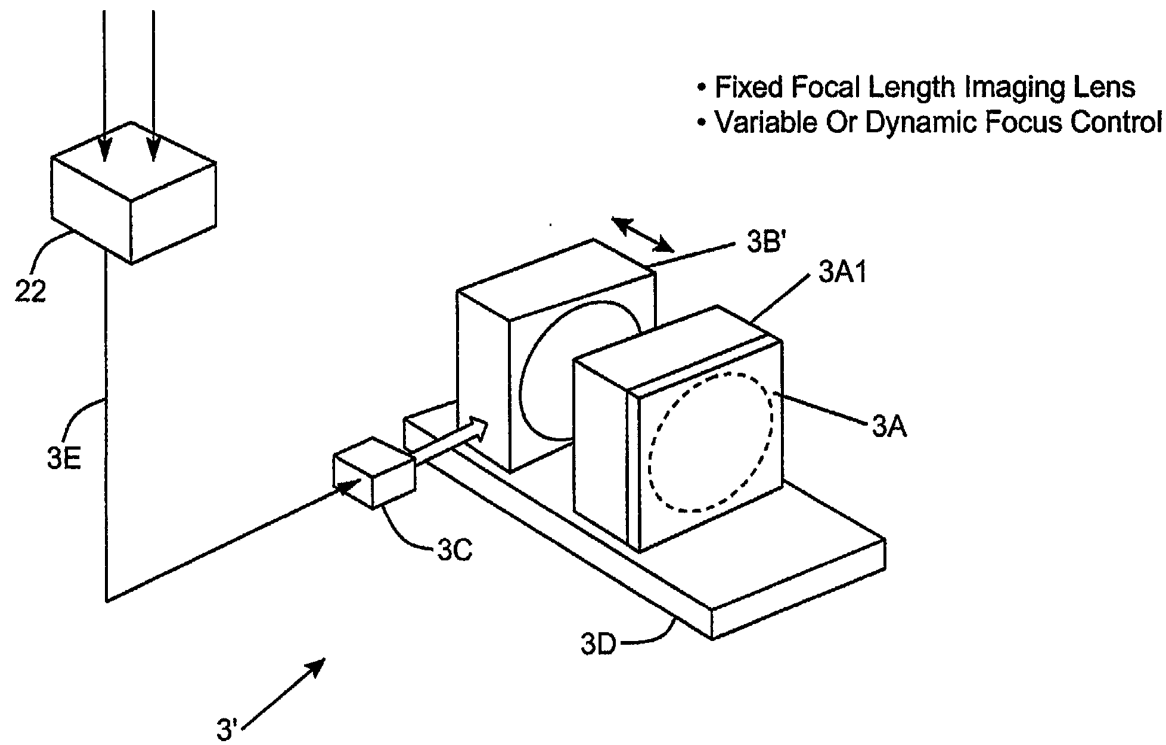


FIG. 2D1



Fixed Focal Length/ Variable Or Dynamic Focus Control 3B'
3A
Stationary 9
19
IMAGE GRABBER
3'
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
21
IMAGE PROCESSING COMPUTER
40B
MICRO-CONTROLLER
764
6A
6B
VLD DRIVER
18
11
12
299

FIG. 2D2



• Fixed Focal Length Imaging Lens
• Variable Or Dynamic Focus Control
3B'
3A1
3A
22
3E
3C
3D
3'

FIG. 2D3

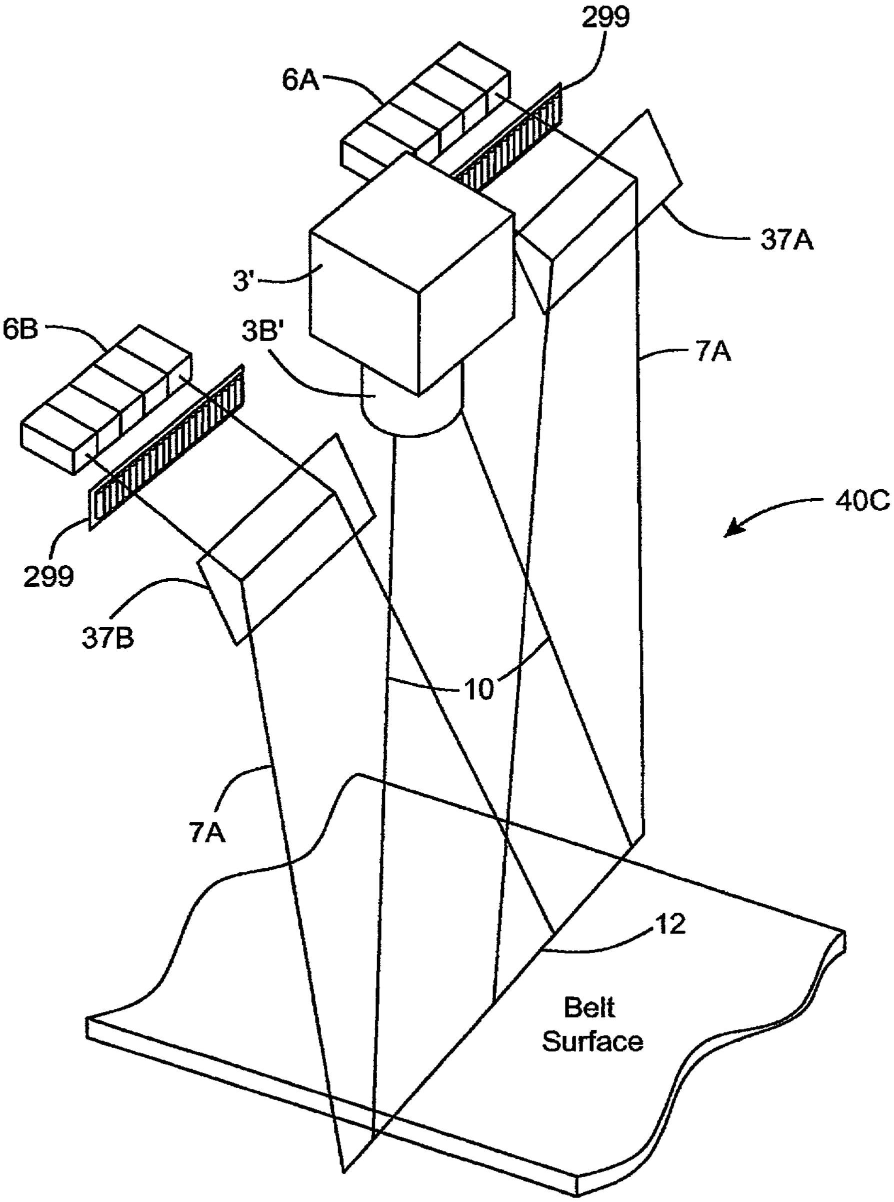


FIG. 2E1

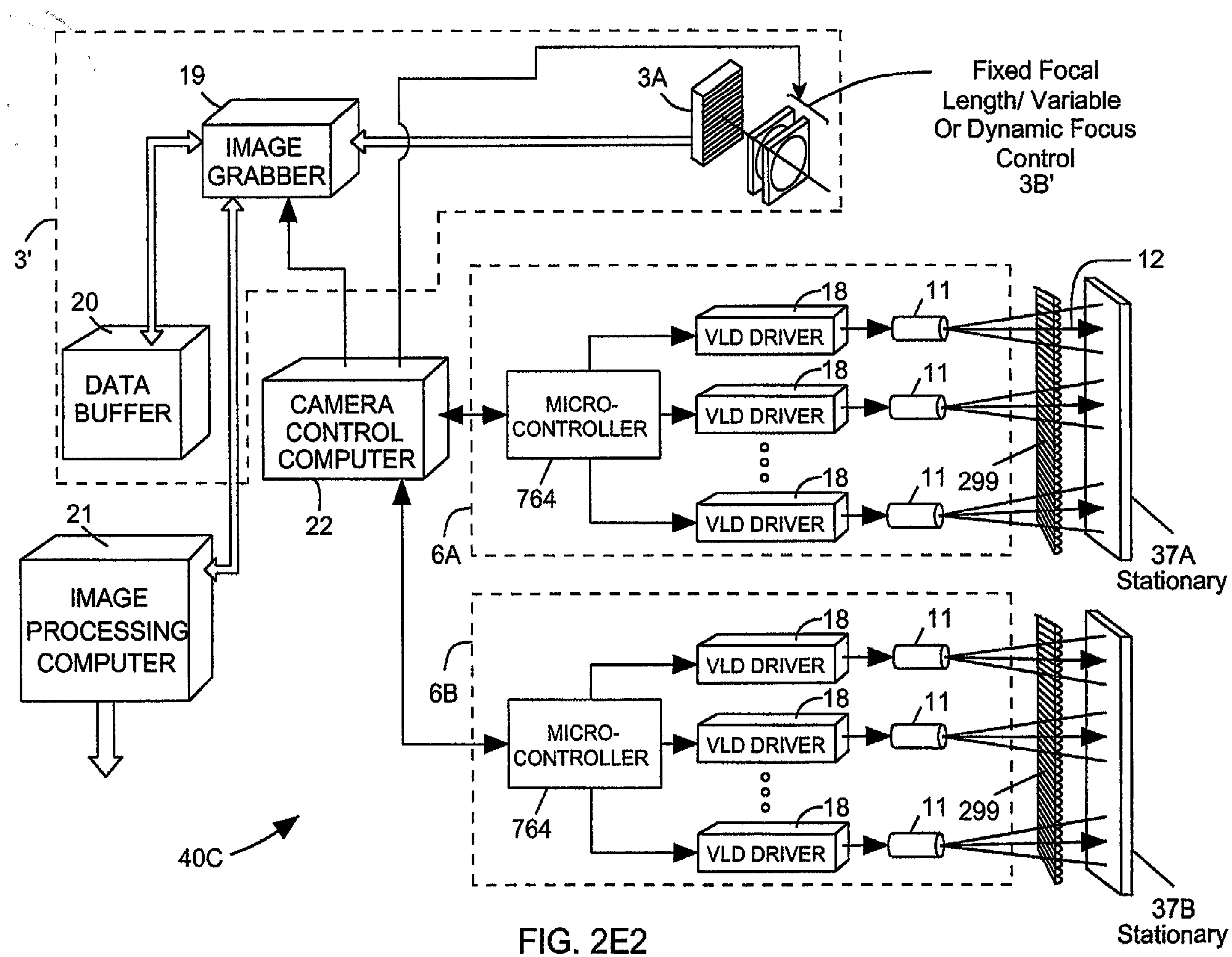

Fixed Focal Length/ Variable Or Dynamic Focus Control 3B'
3A
19
IMAGE GRABBER
3'
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
21
IMAGE PROCESSING COMPUTER
40C
12
MICRO-CONTROLLER
764
6A
6B
VLD DRIVER
18
11
299
37A Stationary
37B Stationary

FIG. 2E2

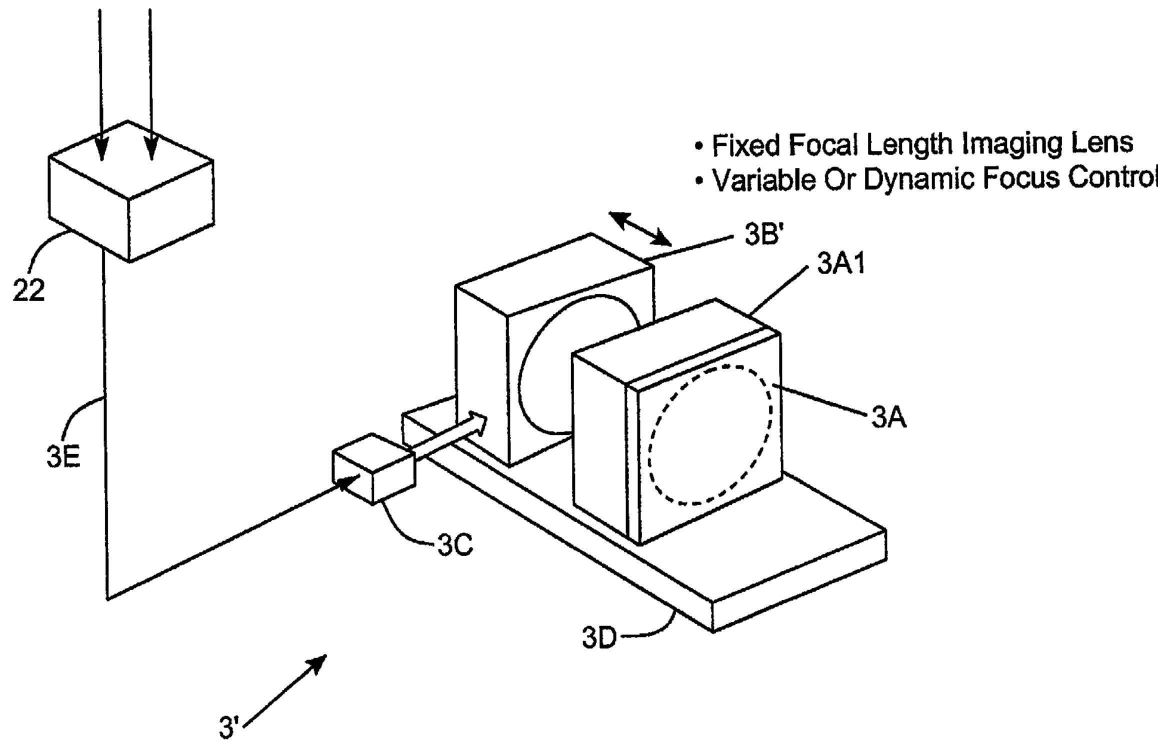

• Fixed Focal Length Imaging Lens
• Variable Or Dynamic Focus Control
3B'
3A1
3A
22
3E
3C
3D
3'

FIG. 2E3

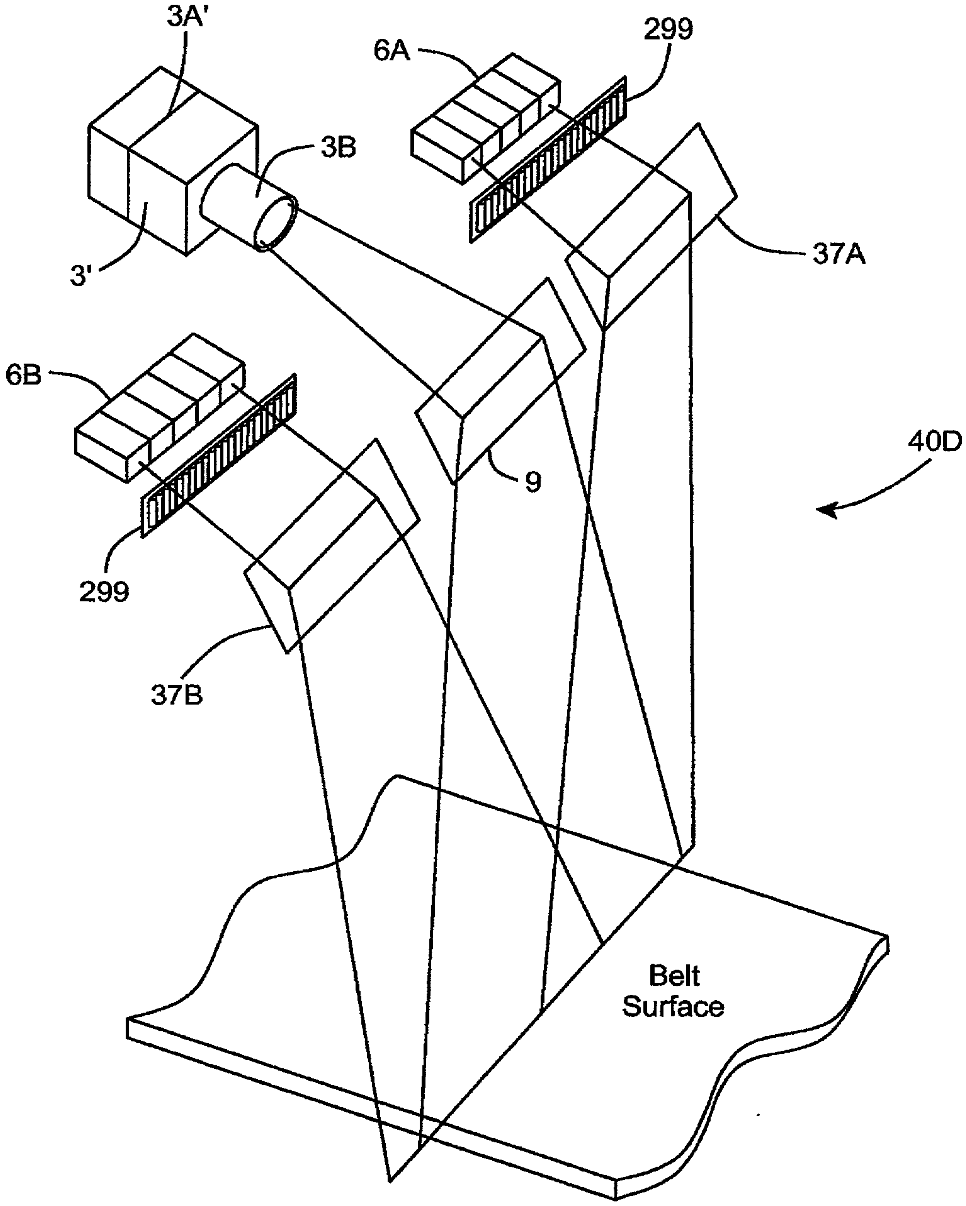
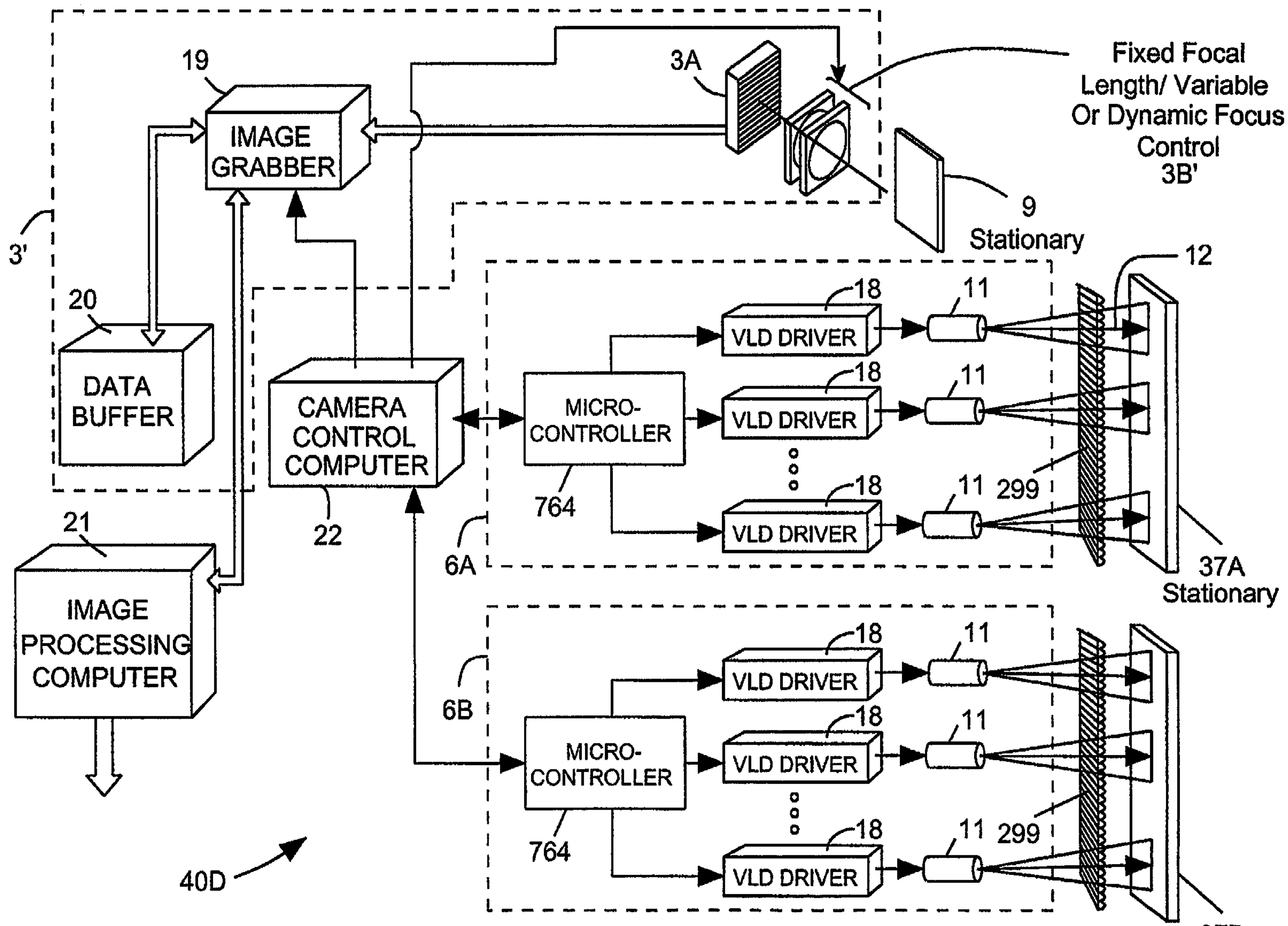


FIG. 2F1



Fixed Focal Length/ Variable Or Dynamic Focus Control 3B'
3A
19
IMAGE GRABBER
9
Stationary
3'
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
12
18
VLD DRIVER
11
MICRO-CONTROLLER
764
299
6A
37A Stationary
21
IMAGE PROCESSING COMPUTER
6B
37B Stationary
40D

FIG. 2F2

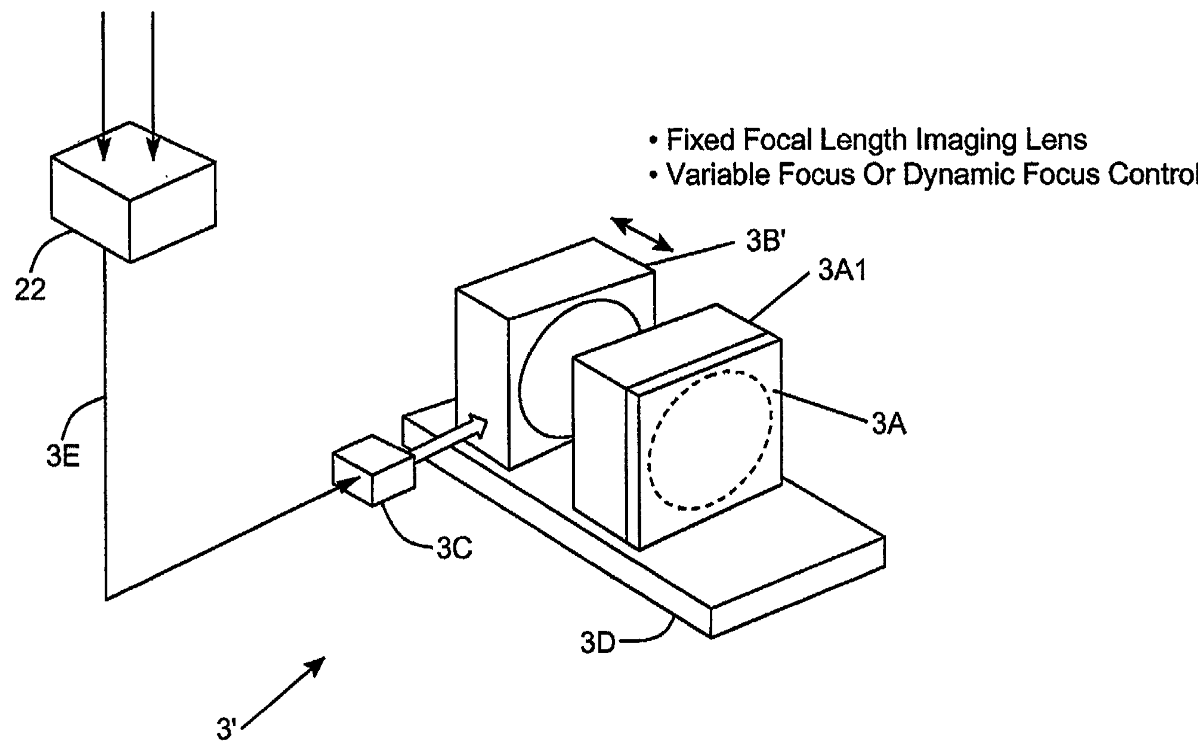

• Fixed Focal Length Imaging Lens
• Variable Focus Or Dynamic Focus Control
22
3E
3C
3D
3B'
3A1
3A
3'

FIG. 2F3

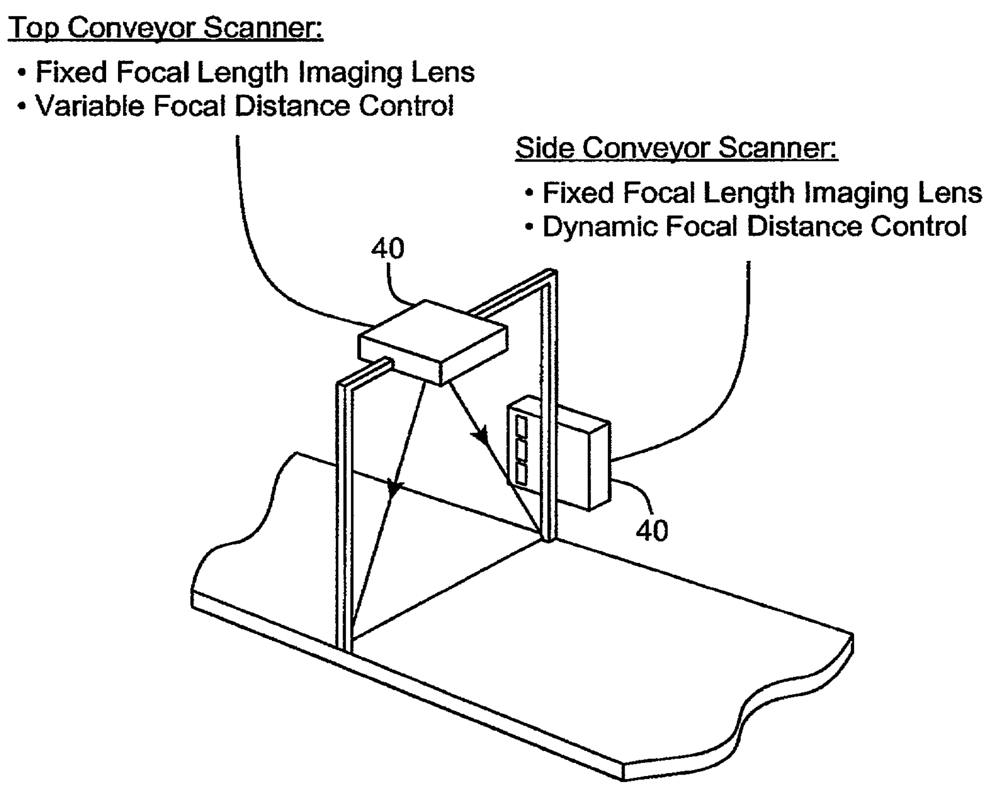

Top Conveyor Scanner:
• Fixed Focal Length Imaging Lens
• Variable Focal Distance Control
Side Conveyor Scanner:
• Fixed Focal Length Imaging Lens
• Dynamic Focal Distance Control
40
40

FIG. 2G

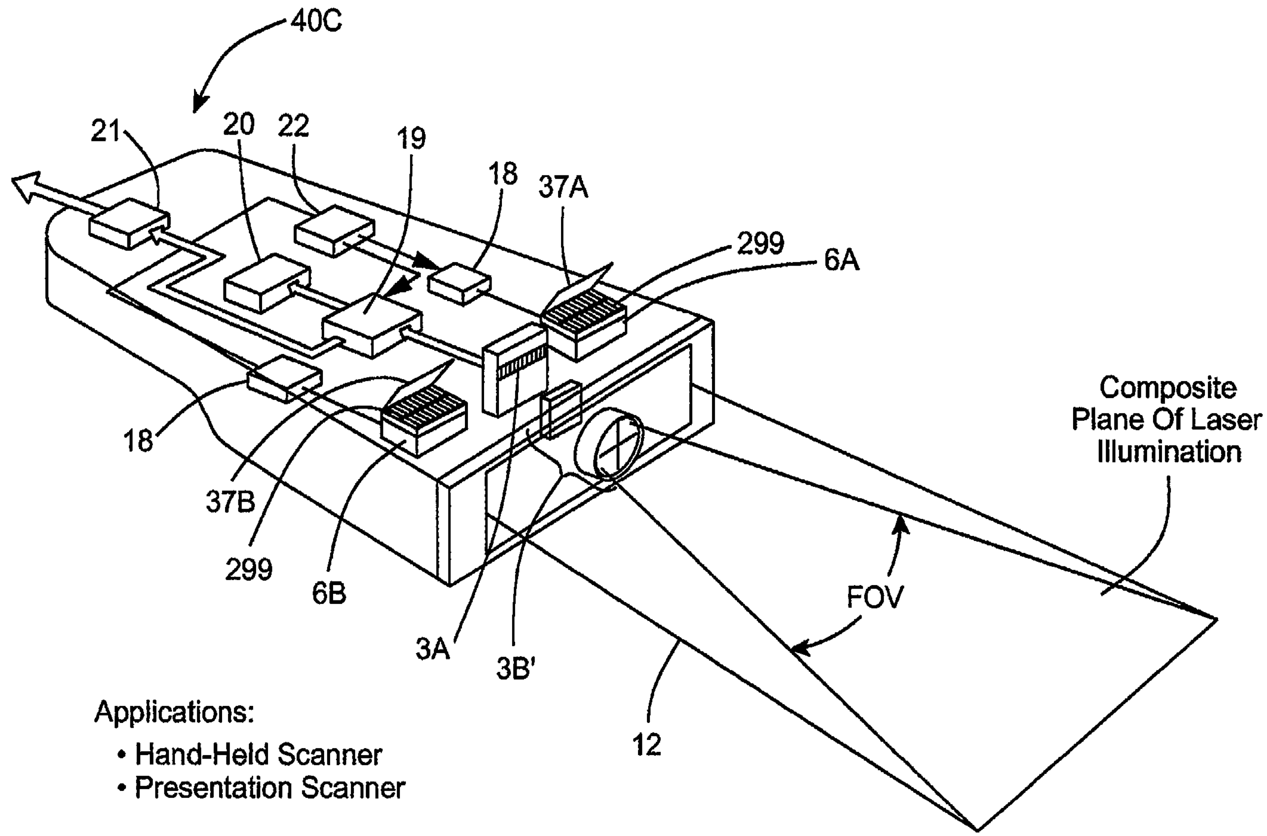

40C
21
20
22
19
18
37A
299
6A
18
37B
299
6B
3A
3B'
12
FOV
Composite
Plane Of Laser
Illumination
Applications:
• Hand-Held Scanner
• Presentation Scanner

FIG. 2H

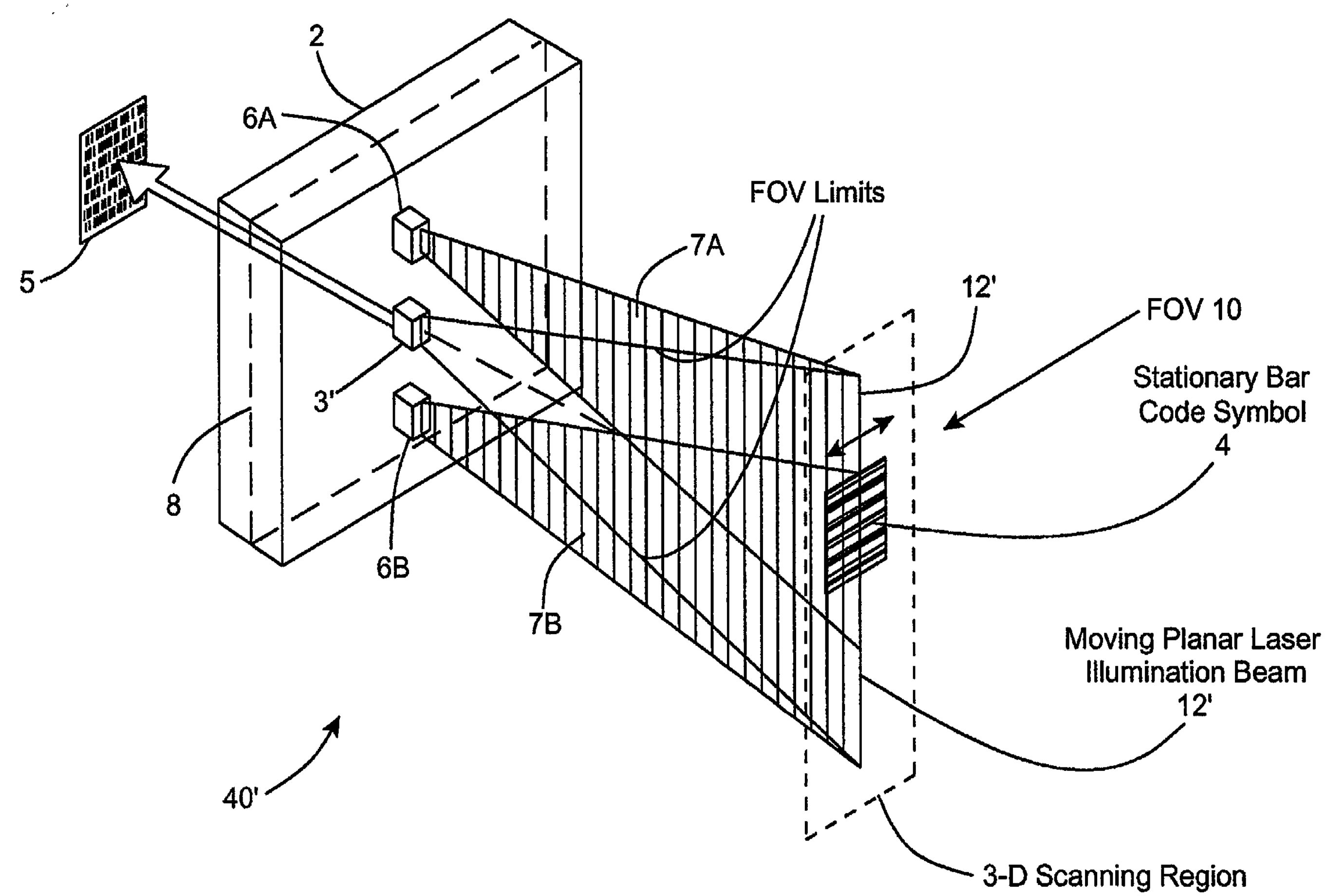

2
6A
5
FOV Limits
7A
12'
FOV 10
Stationary Bar
Code Symbol
4
3'
8
6B
7B
Moving Planar Laser
Illumination Beam
12'
40'
3-D Scanning Region

FIG. 2I1

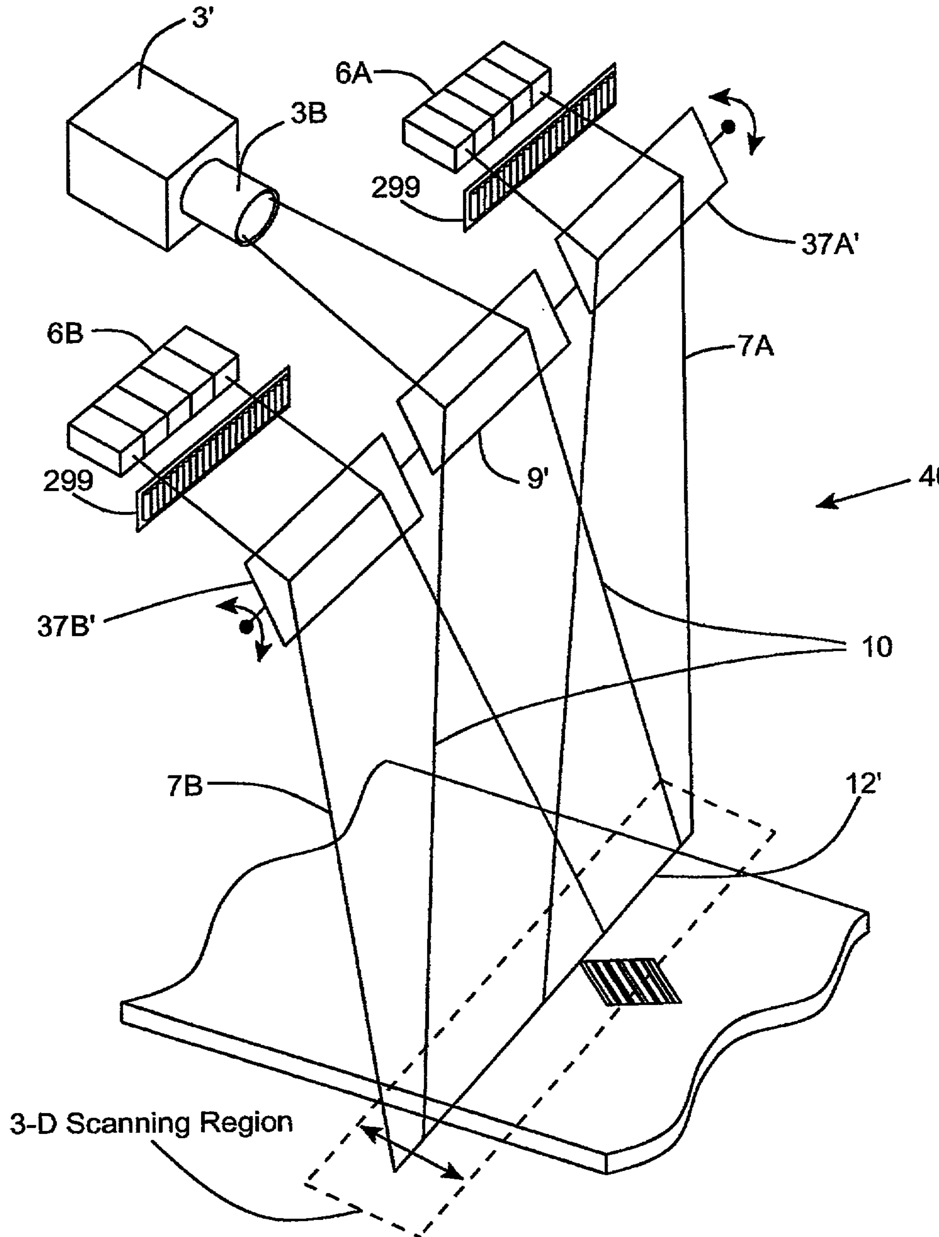


FIG. 2I2

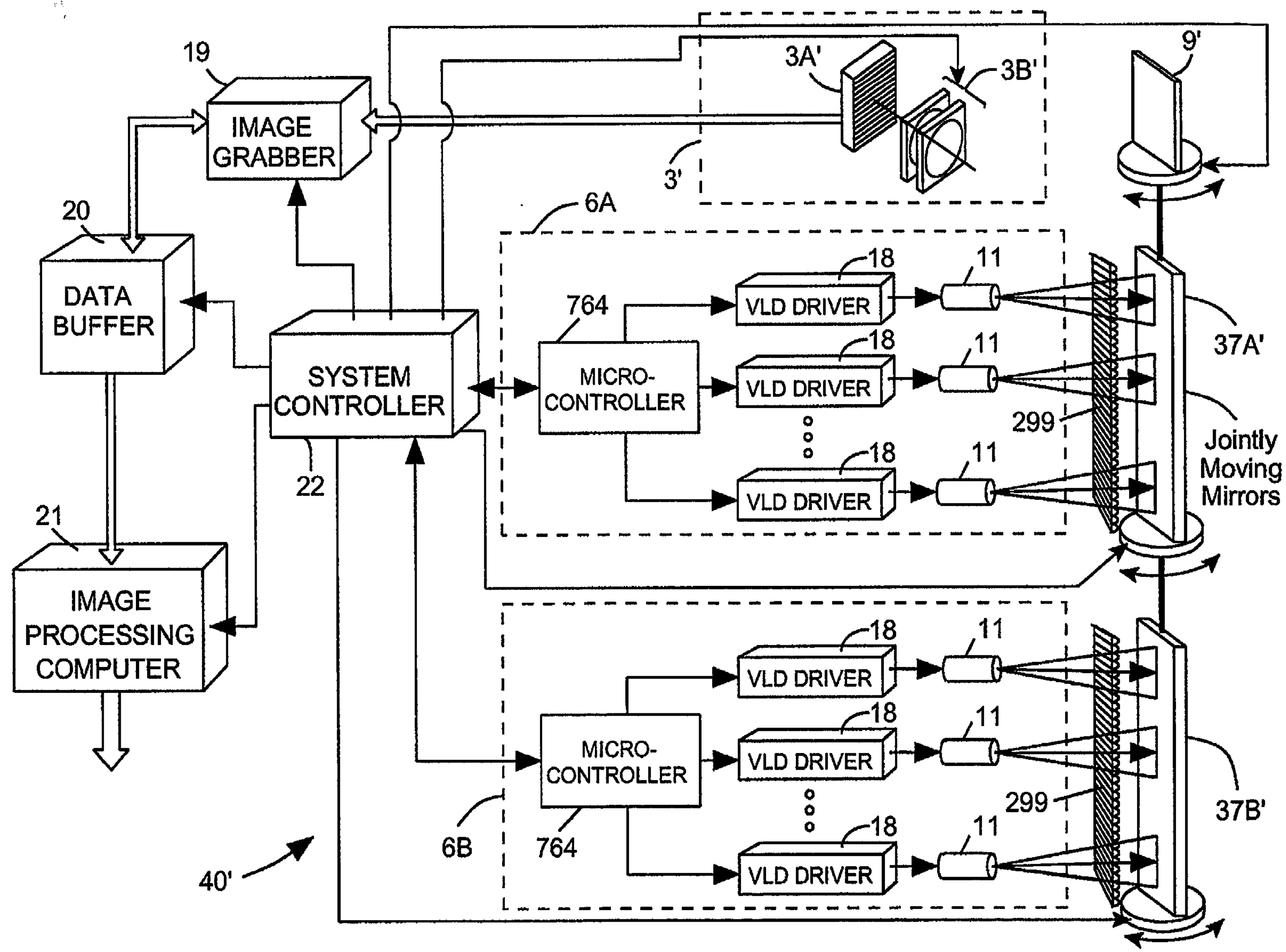

19
IMAGE GRABBER
20
DATA BUFFER
21
IMAGE PROCESSING COMPUTER
SYSTEM CONTROLLER
22
40'
3'
3A'
3B'
9'
6A
764
MICRO-CONTROLLER
18
VLD DRIVER
11
299
37A'
Jointly Moving Mirrors
6B
37B'

FIG. 2I3

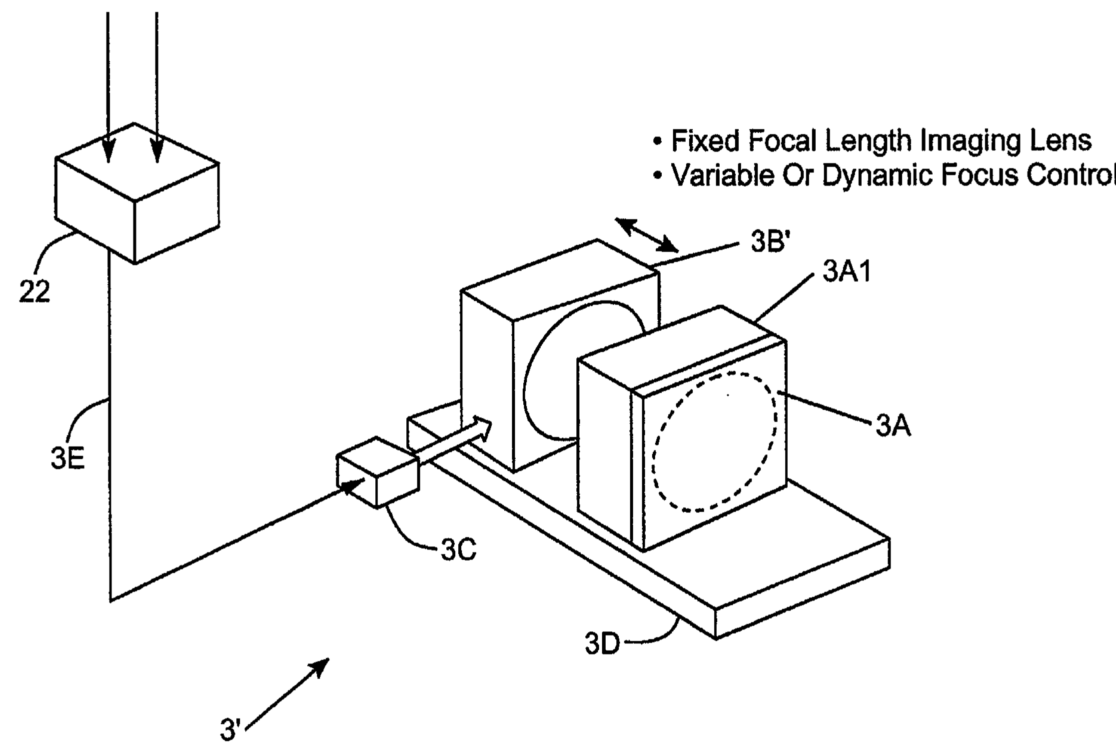

• Fixed Focal Length Imaging Lens
• Variable Or Dynamic Focus Control
3B'
3A1
3A
22
3E
3C
3D
3'

FIG. 2I4

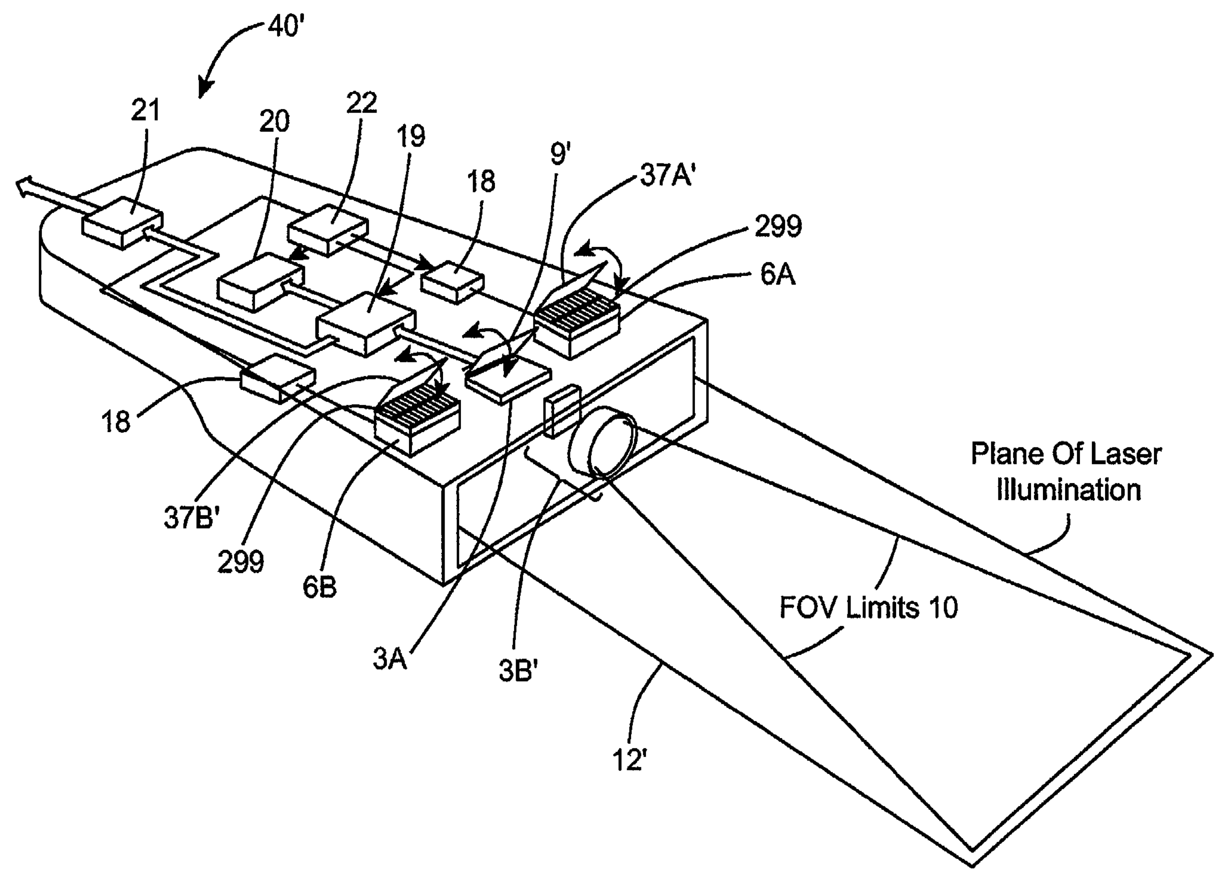

40'
21
20
22
19
18
9'
37A'
299
6A
18
37B'
299
6B
3A
3B'
Plane Of Laser
Illumination
FOV Limits 10
12'

FIG. 2I5

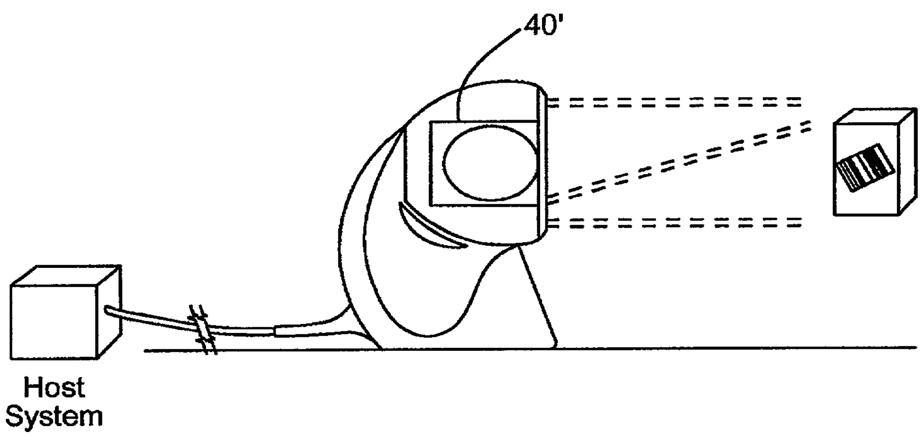


FIG. 216

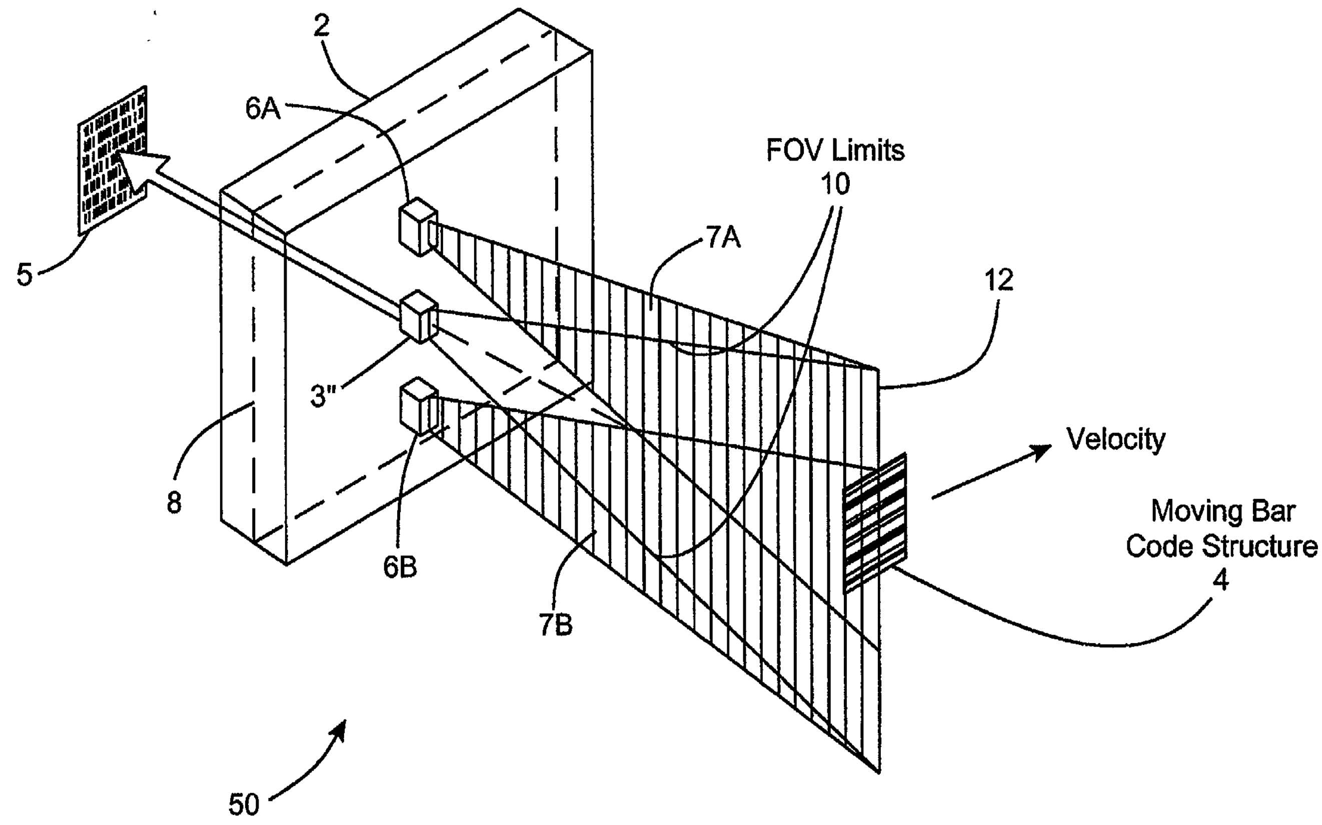

2
6A
5
FOV Limits
10
7A
12
3"
8
6B
7B
Velocity
Moving Bar
Code Structure
4
50

FIG. 3A

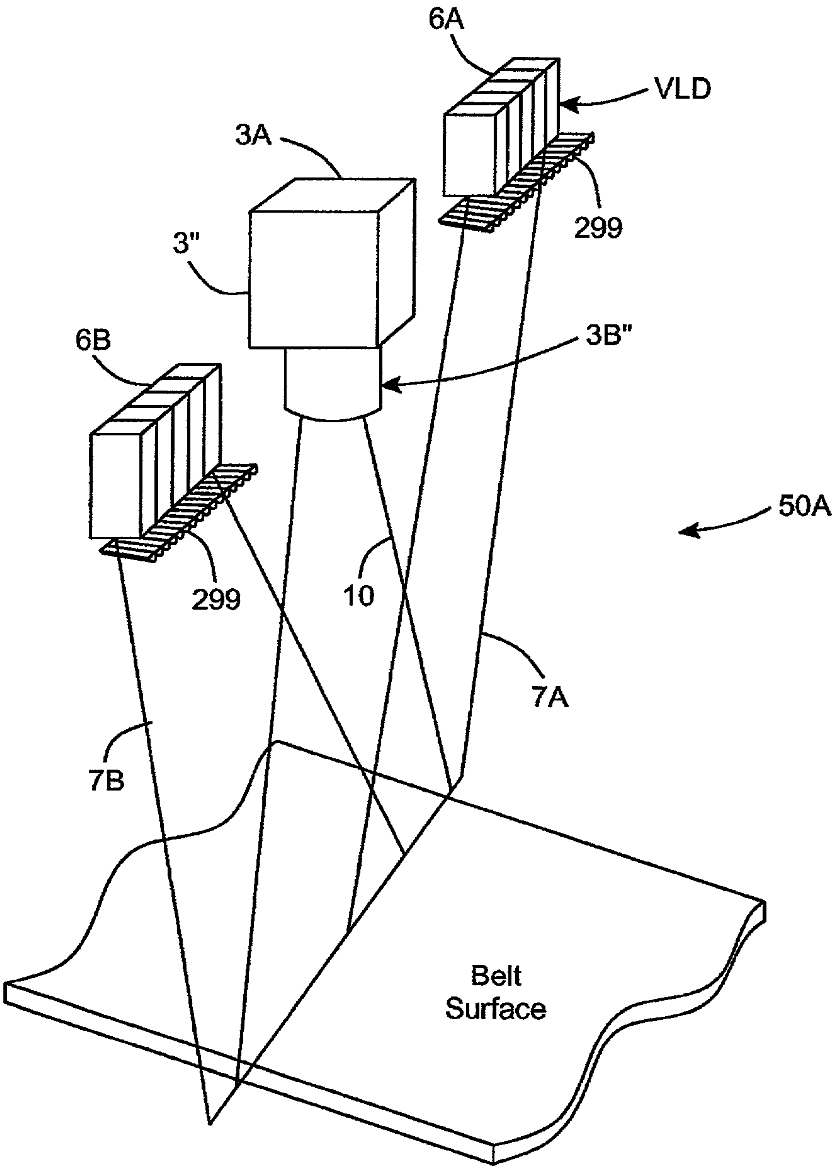


FIG. 3B1

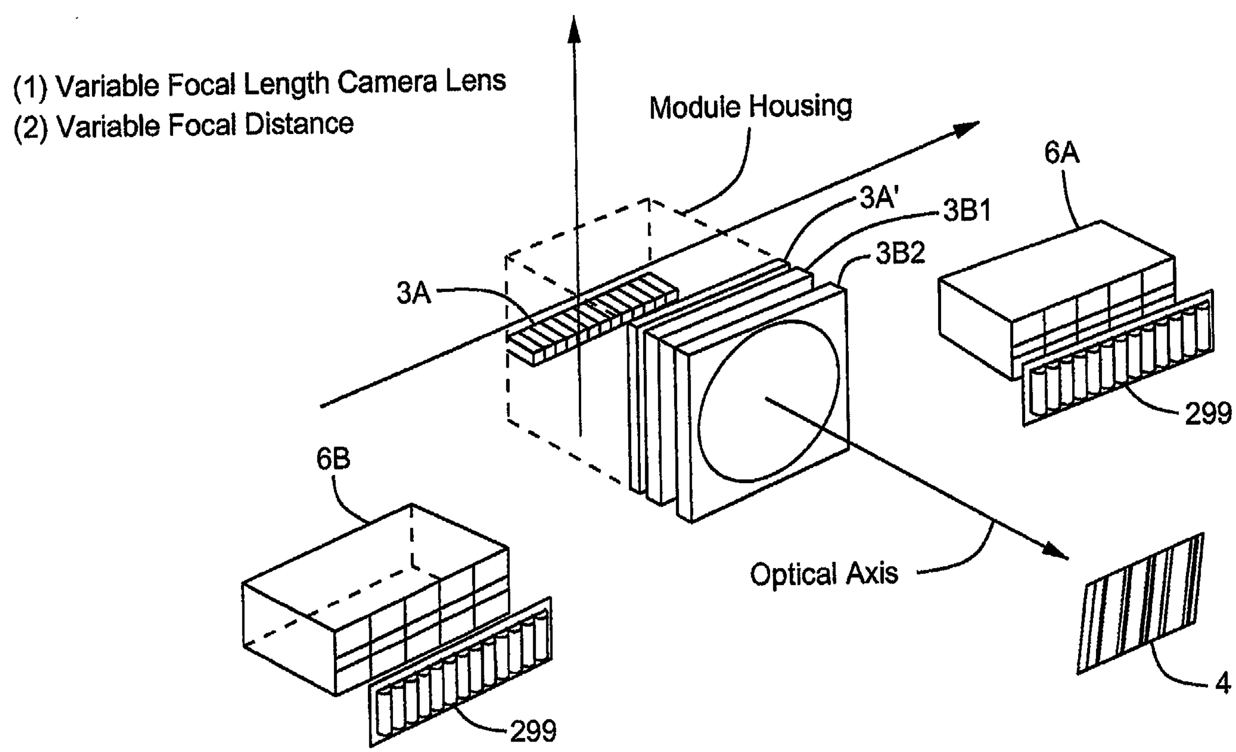
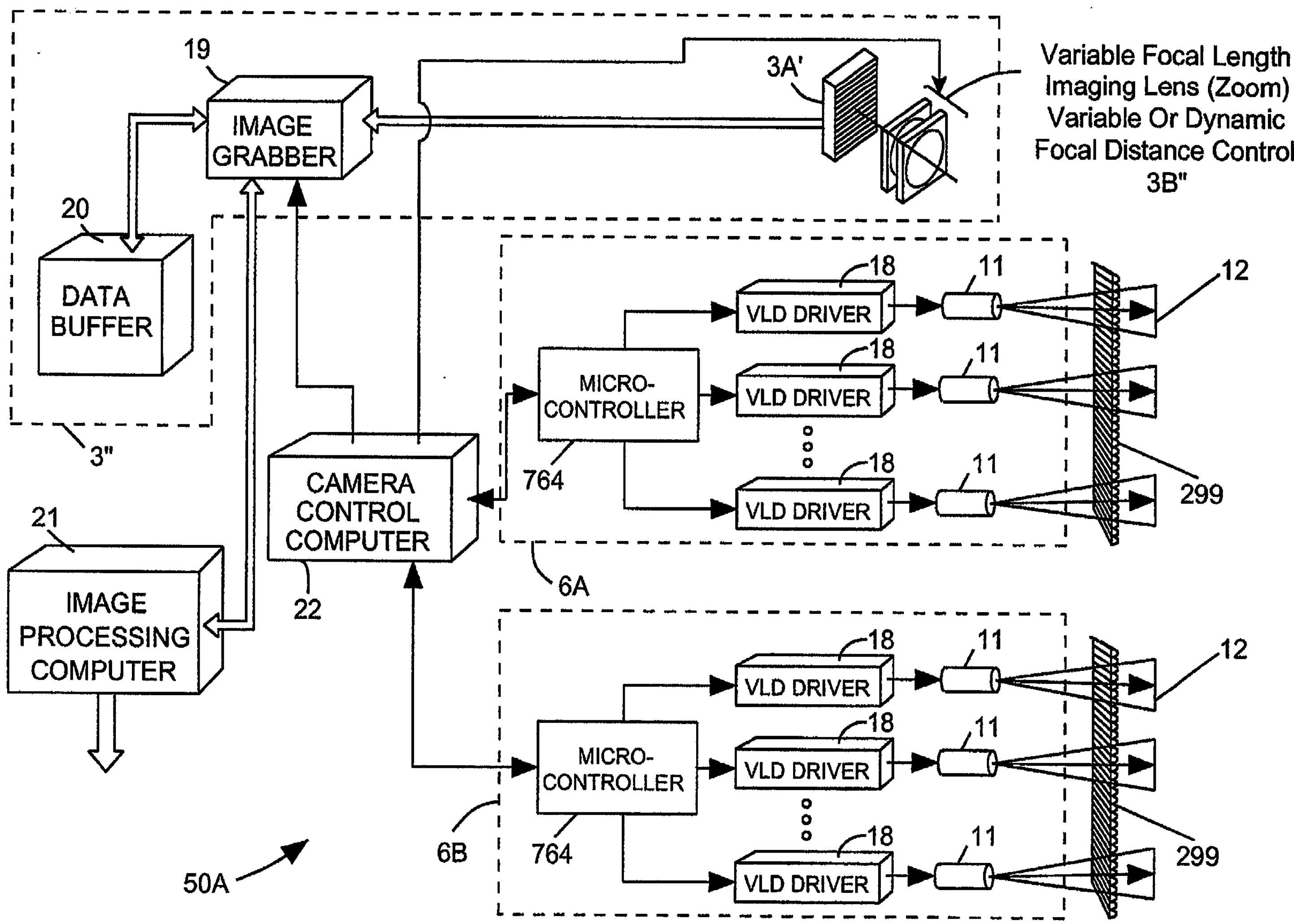
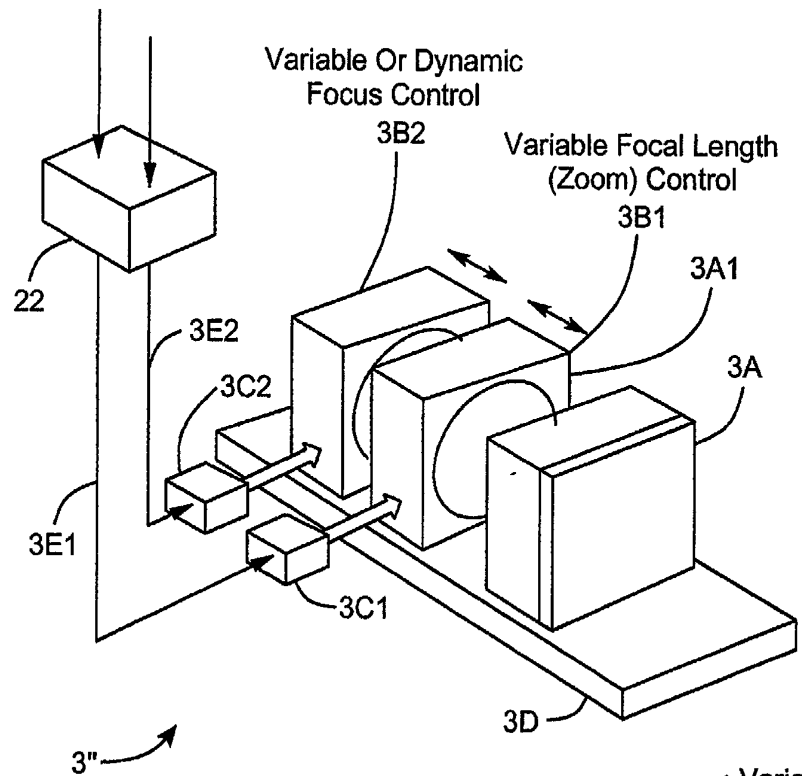

(1) Variable Focal Length Camera Lens
(2) Variable Focal Distance
Module Housing
3A
3A'
3B1
3B2
6A
299
6B
299
Optical Axis
4

FIG. 3B2



Variable Focal Length Imaging Lens (Zoom) Variable Or Dynamic Focal Distance Control 3B"
3A'
19
IMAGE GRABBER
20
DATA BUFFER
3"
21
IMAGE PROCESSING COMPUTER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
764
VLD DRIVER
18
11
12
299
6A
6B
50A

FIG. 3C1



• Variable Focal Length Camera Lens
• Variable Focal Distance

FIG. 3C2

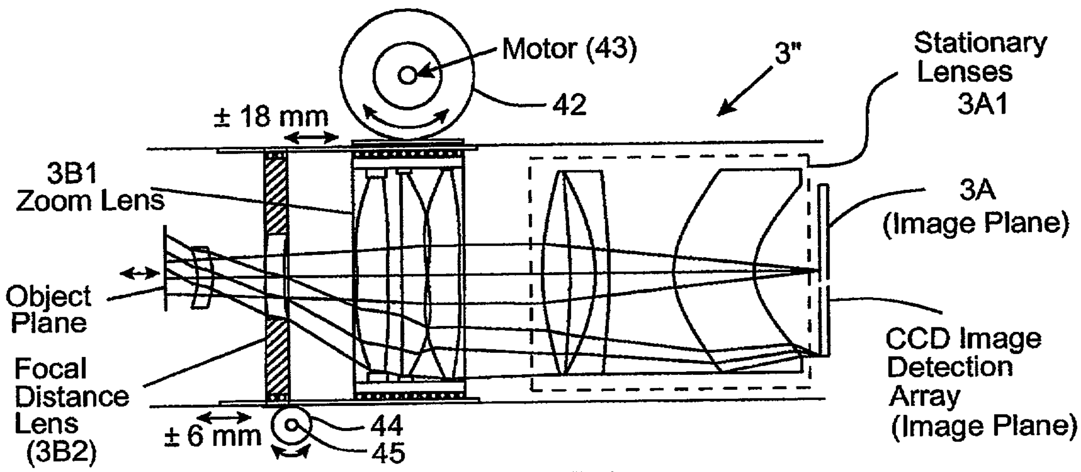


FIG. 3D1

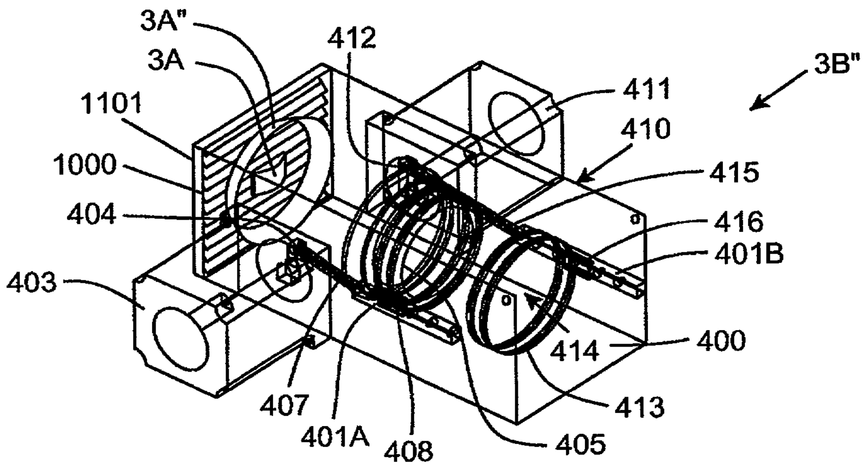


FIG. 3D2

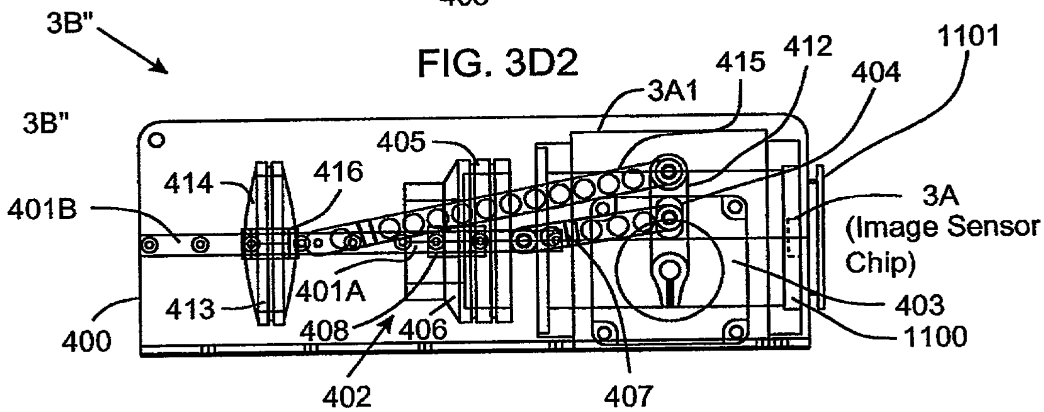


FIG. 3D3

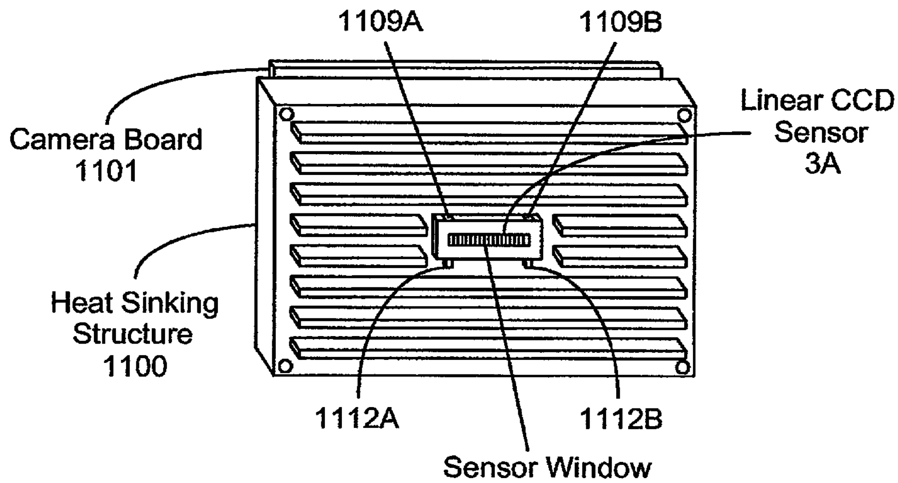


FIG. 3D4

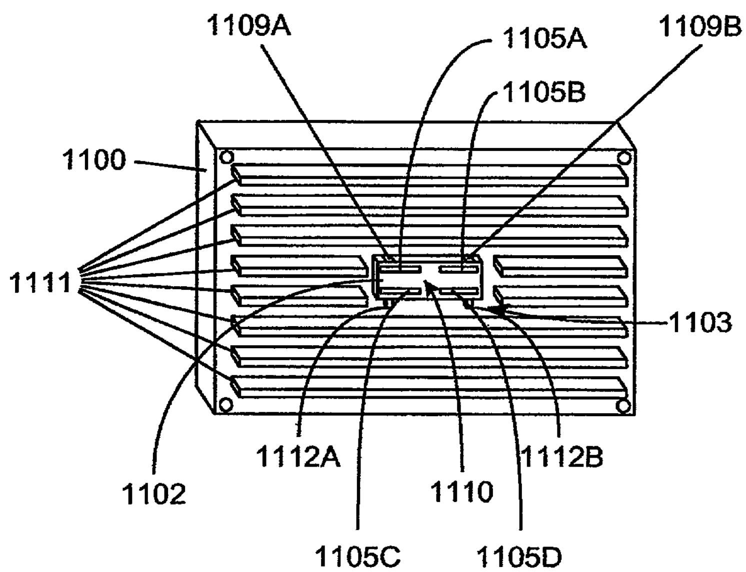


FIG. 3D5

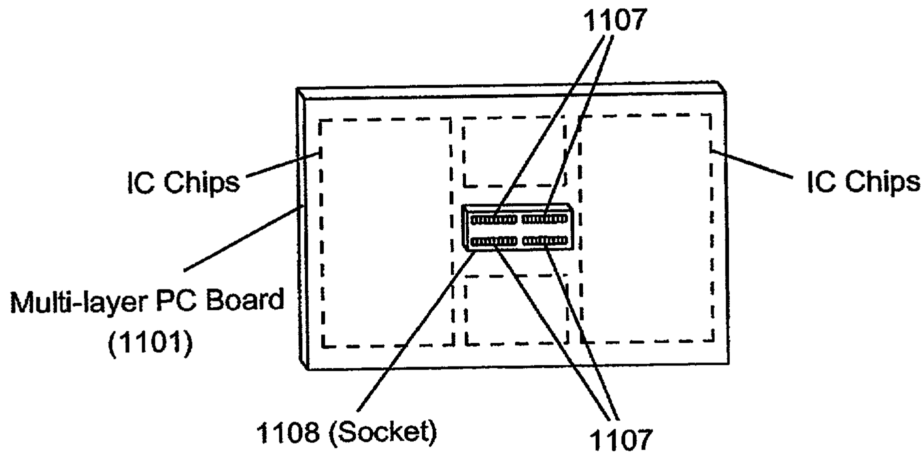


FIG. 3D6

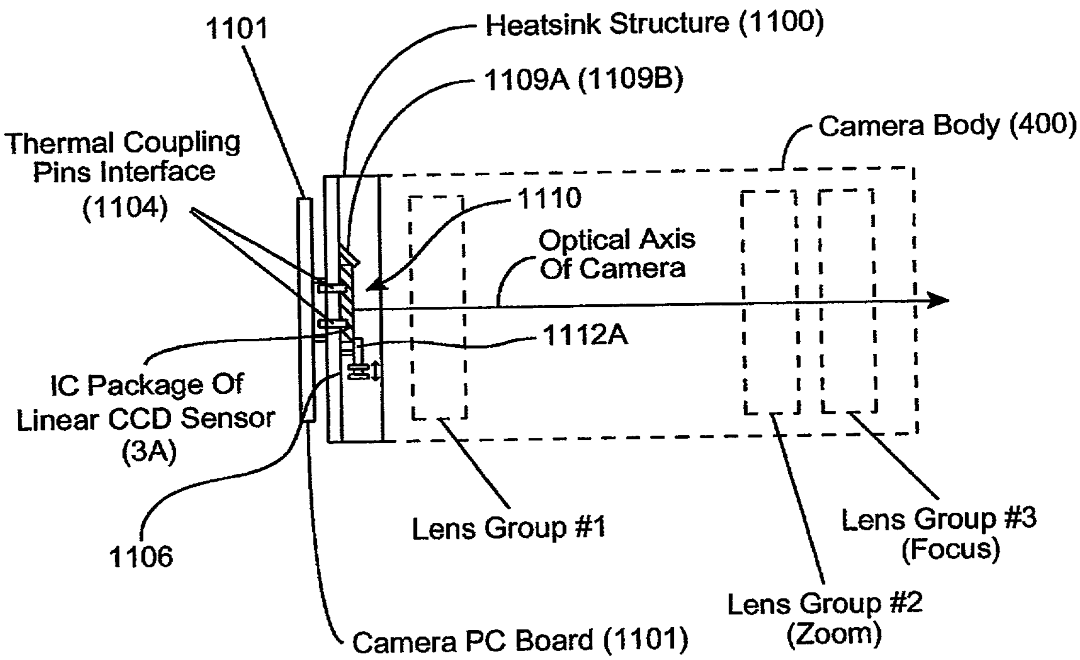


FIG. 3D7

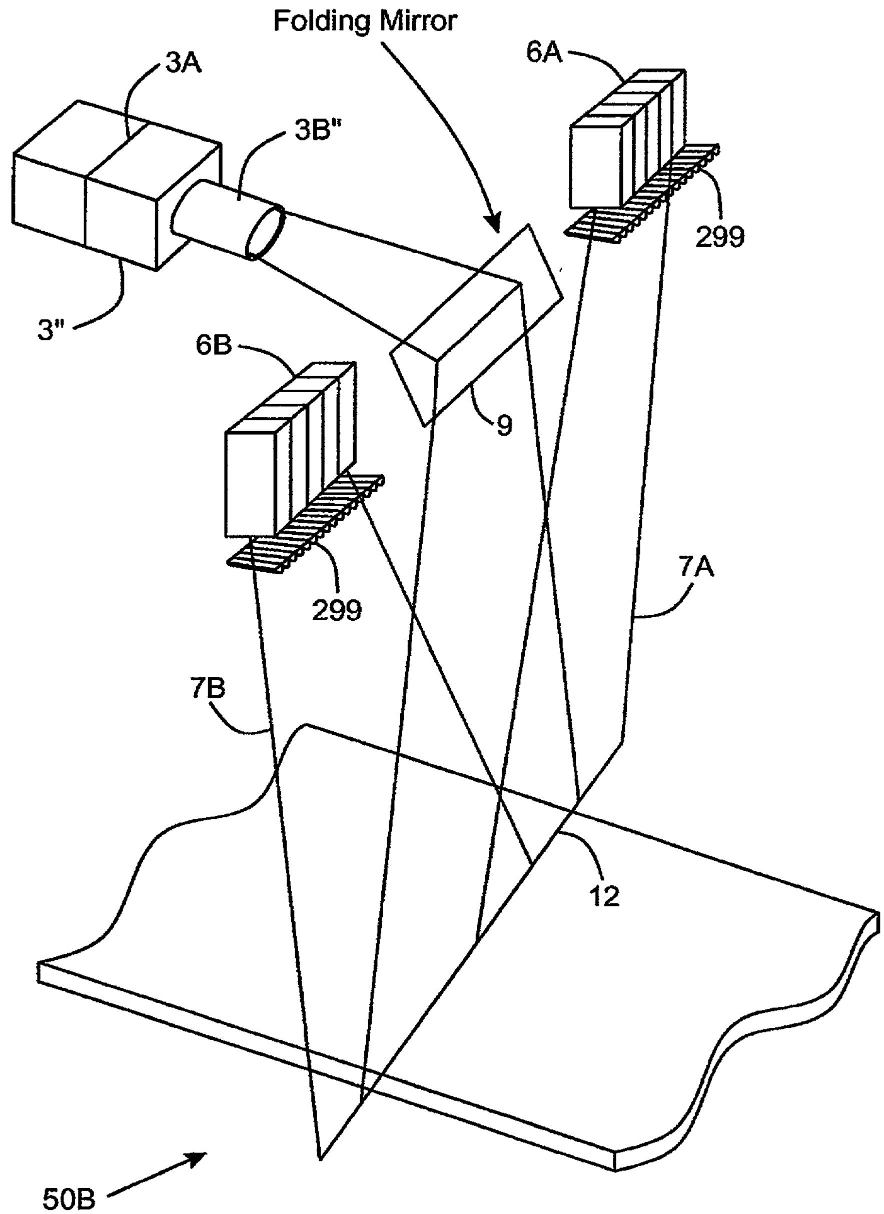


FIG. 3E1

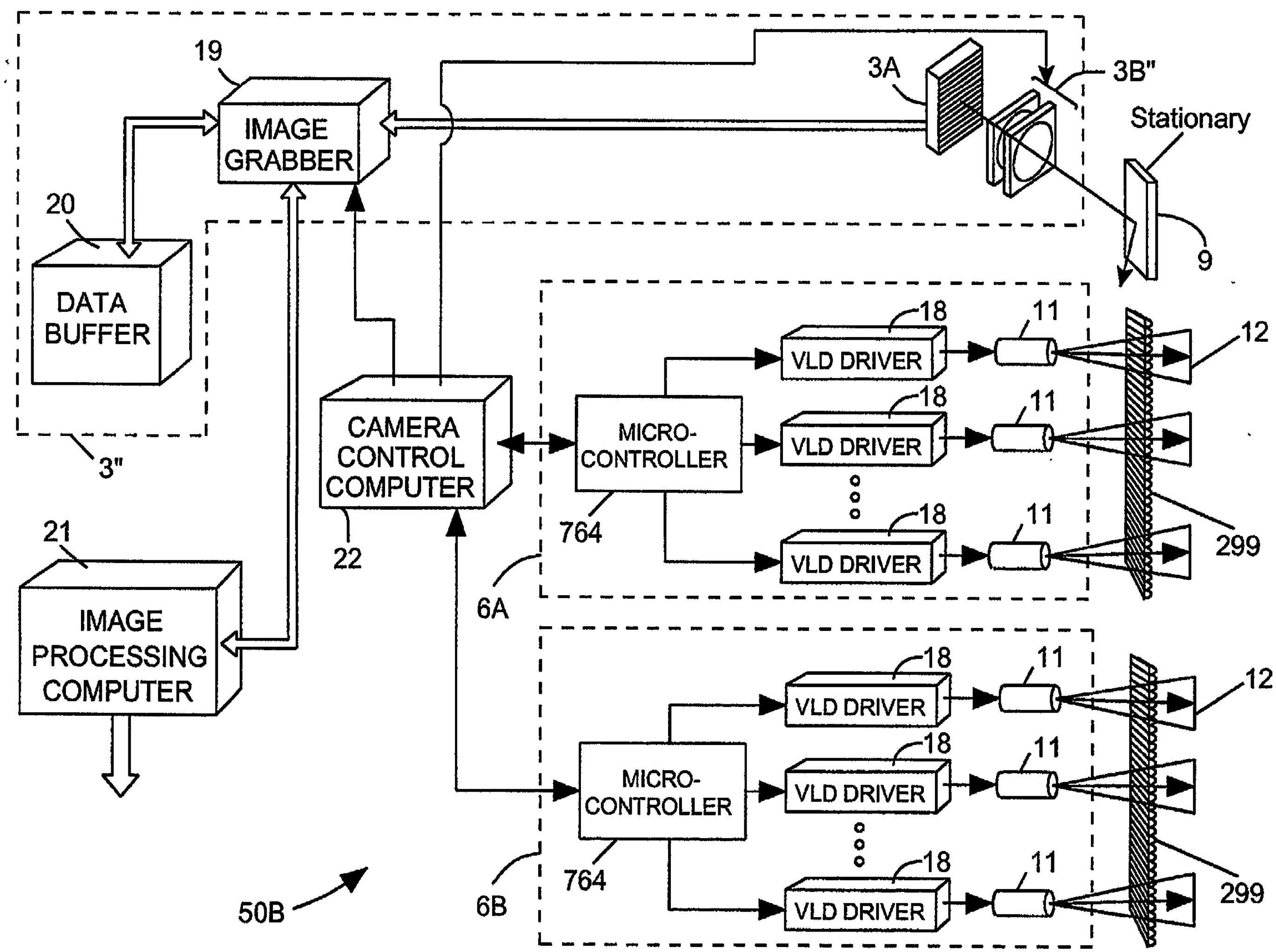

19
IMAGE GRABBER
20
DATA BUFFER
3"
21
IMAGE PROCESSING COMPUTER
CAMERA CONTROL COMPUTER
22
3A
3B"
Stationary
9
MICRO-CONTROLLER
764
6A
6B
VLD DRIVER
18
11
12
299
50B

FIG. 3E2

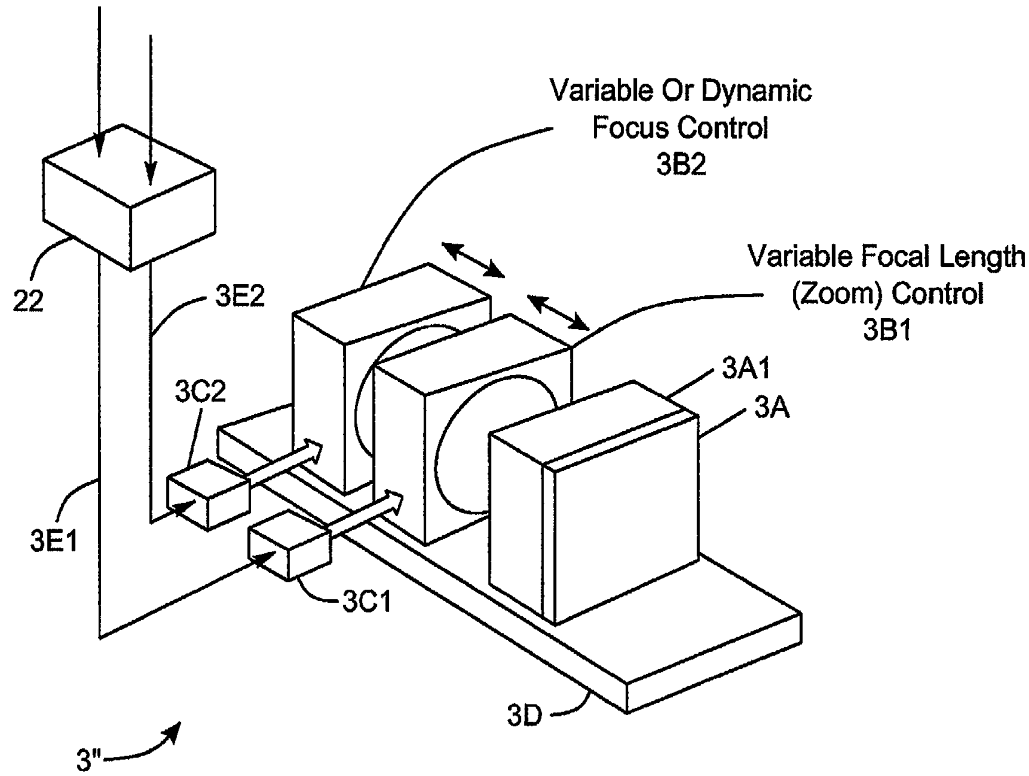

Variable Or Dynamic
Focus Control
3B2
Variable Focal Length
(Zoom) Control
3B1
22
3E2
3C2
3A1
3A
3E1
3C1
3D
3"

FIG. 3E3

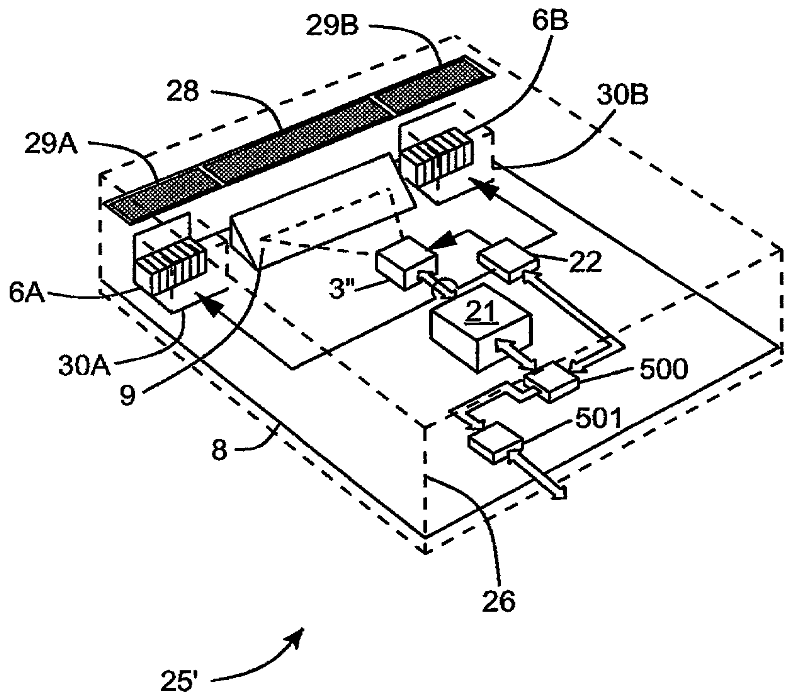


FIG. 3E4

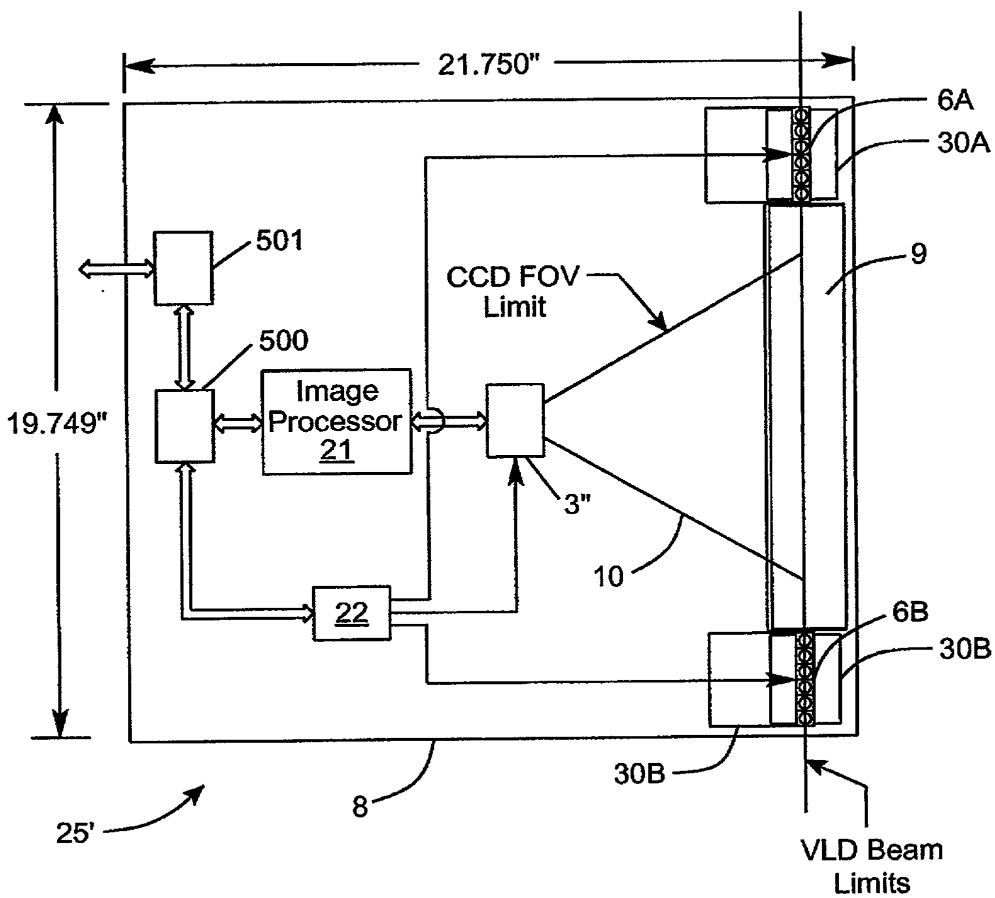
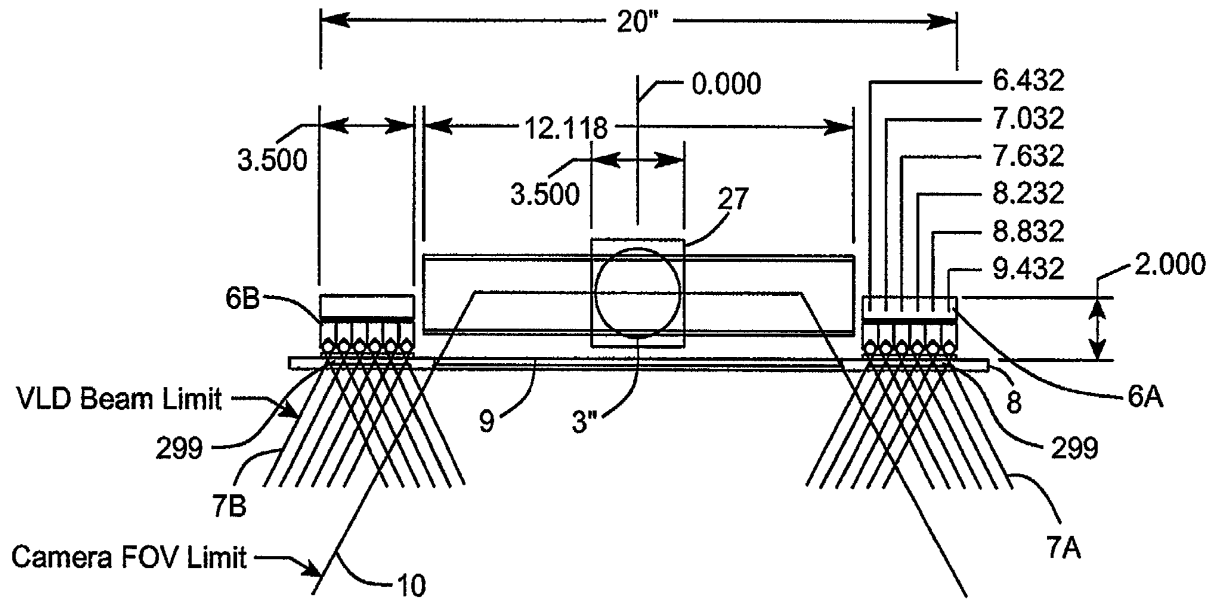

21.750"
19.749"
6A
30A
501
9
CCD FOV
Limit
500
Image
Processor
21
3"
10
22
6B
30B
30B
8
25'
VLD Beam
Limits

FIG. 3E5



20"
0.000
12.118
3.500
3.500
27
6.432
7.032
7.632
8.232
8.832
9.432
2.000
6B
6A
8
VLD Beam Limit
299
9
3"
299
7B
7A
Camera FOV Limit
10

FIG. 3E6

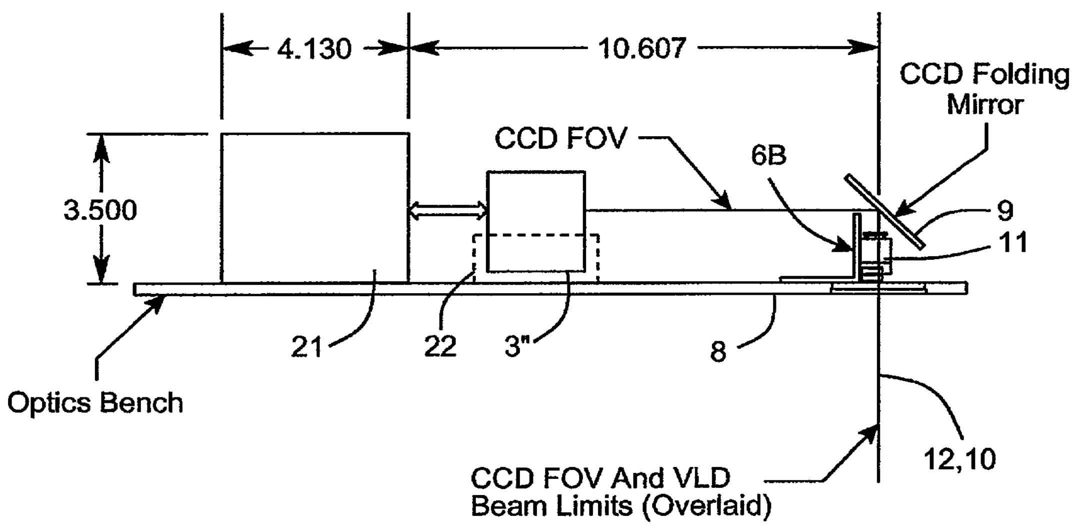

4.130
10.607
CCD Folding
Mirror
CCD FOV
6B
3.500
9
11
21
22
3"
8
Optics Bench
12,10
CCD FOV And VLD
Beam Limits (Overlaid)

FIG. 3E7

* Variable FOV

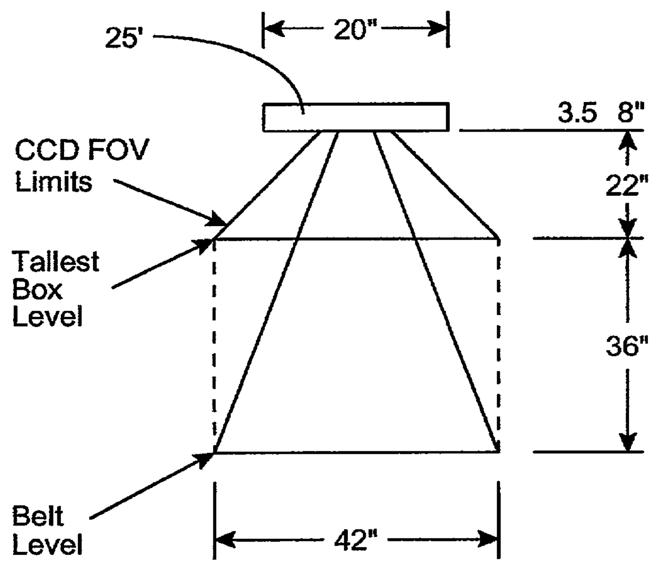


FIG. 3E8

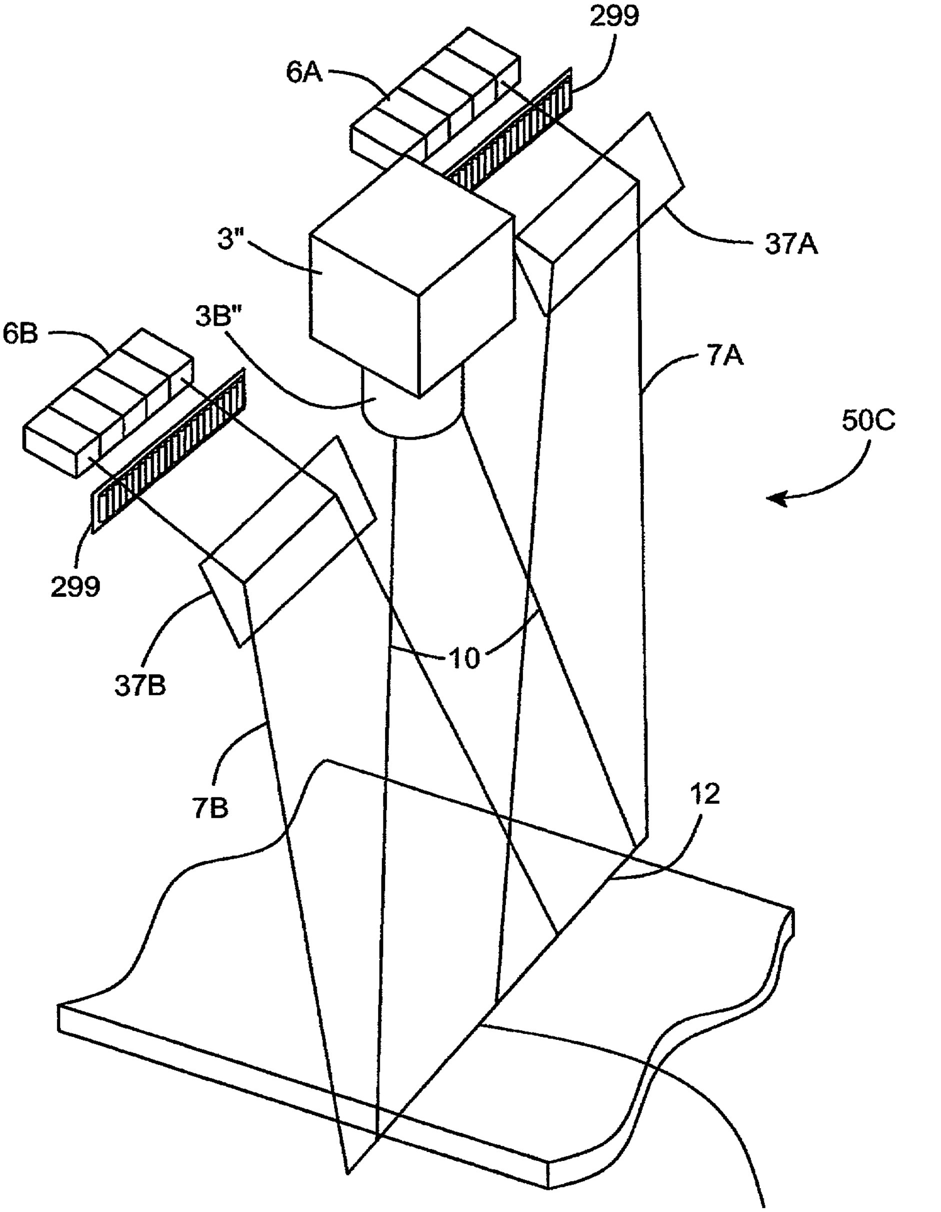
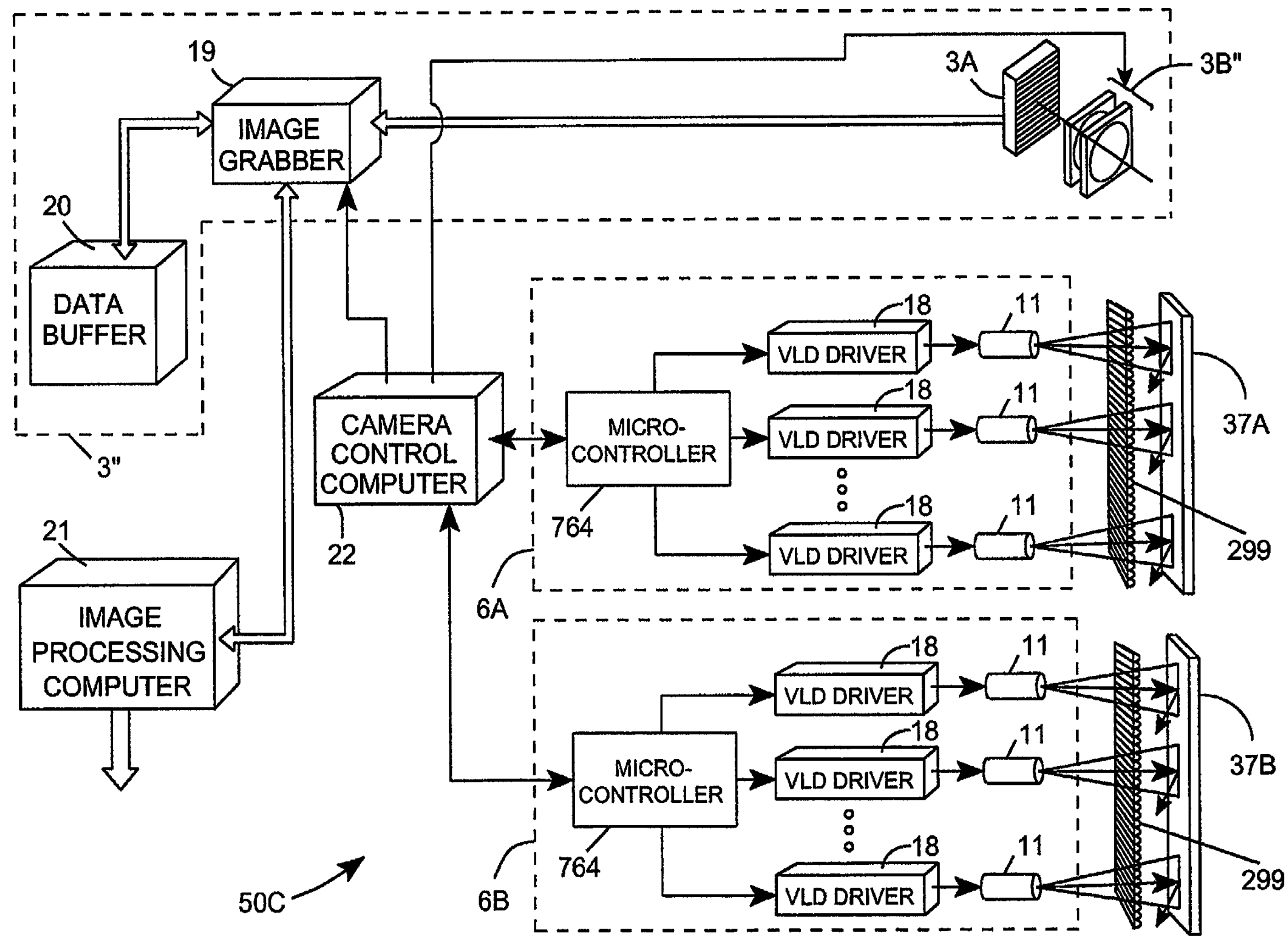

299
6A
3"
37A
3B"
6B
7A
50C
299
10
37B
7B
12
Stationary Planar Laser Beam

FIG. 3F1



19
IMAGE GRABBER
20
DATA BUFFER
3"
21
IMAGE PROCESSING COMPUTER
CAMERA CONTROL COMPUTER
22
3A
3B"
MICRO-CONTROLLER
764
6A
VLD DRIVER
18
11
37A
299
MICRO-CONTROLLER
764
6B
37B
50C

FIG. 3F2

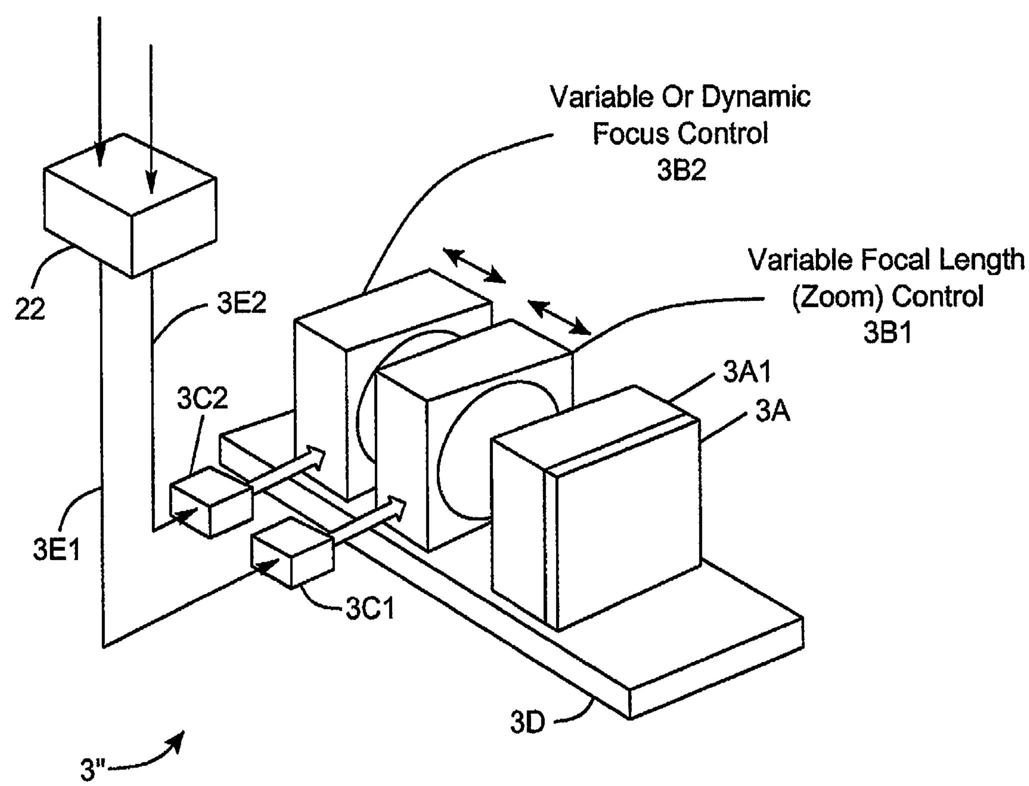

Variable Or Dynamic
Focus Control
3B2
Variable Focal Length
(Zoom) Control
3B1
3A1
3A
22
3E2
3C2
3E1
3C1
3D
3"

FIG. 3F3

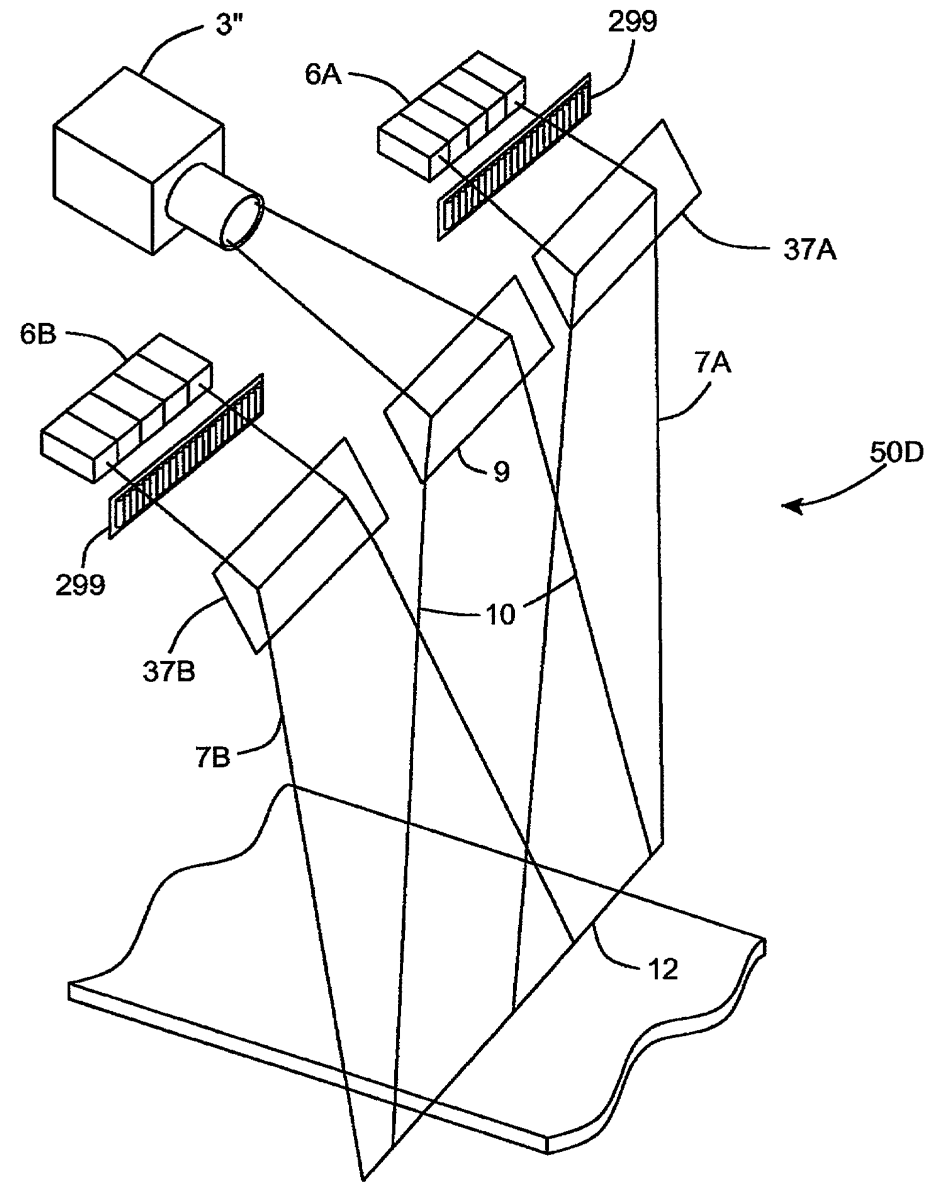


FIG. 3G1

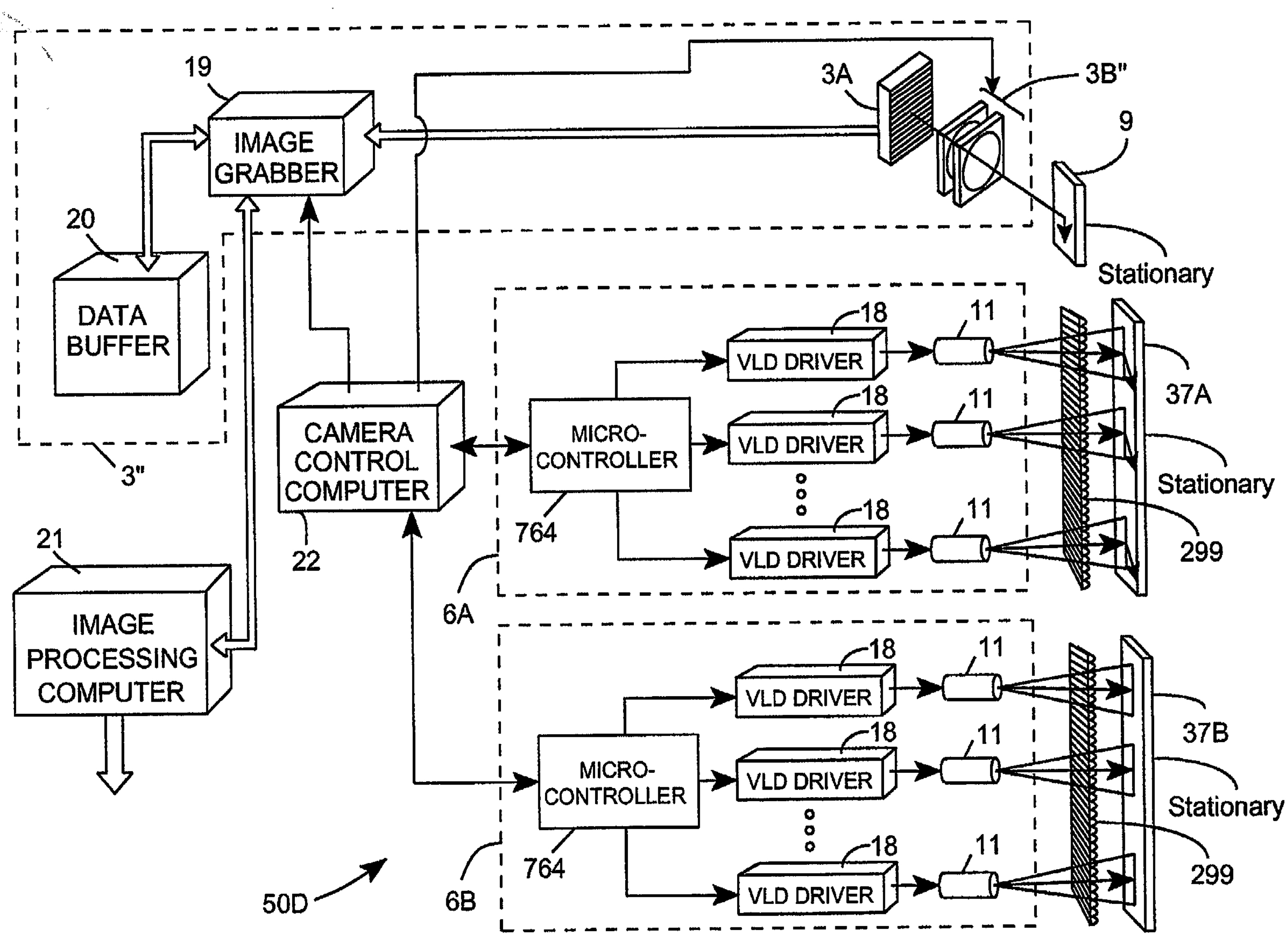

19
IMAGE GRABBER
20
DATA BUFFER
3"
21
IMAGE PROCESSING COMPUTER
CAMERA CONTROL COMPUTER
22
3A
3B"
9
Stationary
MICRO-CONTROLLER
764
6A
VLD DRIVER
18
11
37A
Stationary
299
MICRO-CONTROLLER
764
6B
VLD DRIVER
18
11
37B
Stationary
299
50D

FIG. 3G2

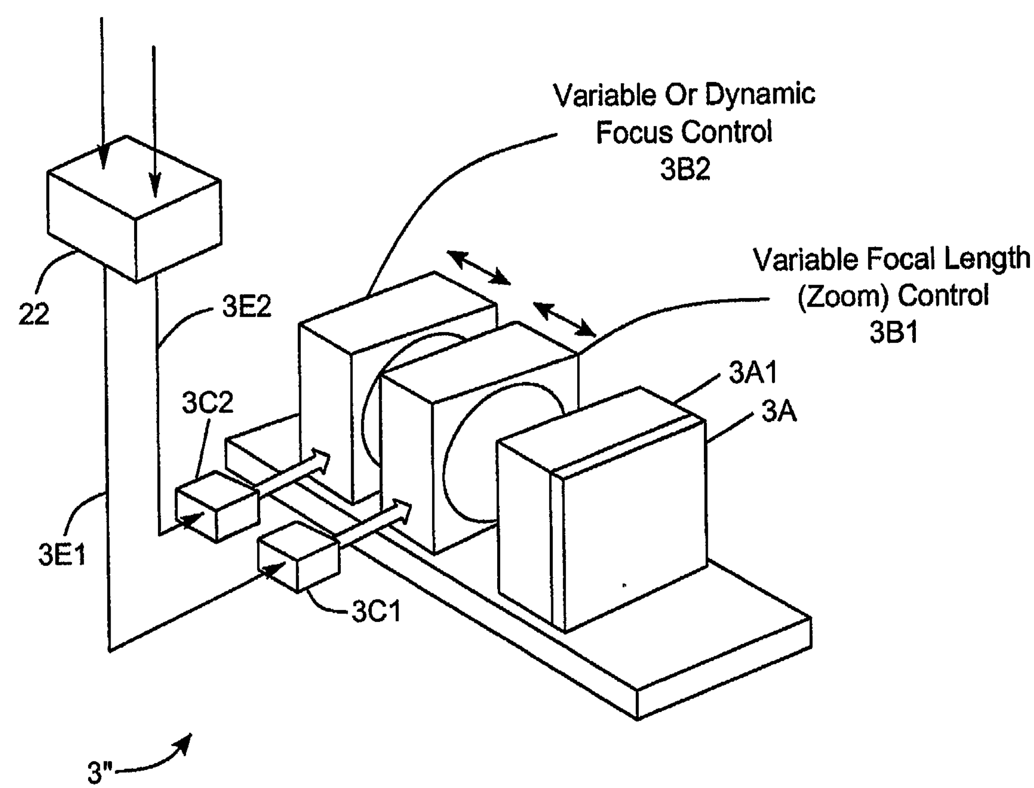

Variable Or Dynamic
Focus Control
3B2
Variable Focal Length
(Zoom) Control
3B1
3A1
3A
22
3E2
3C2
3E1
3C1
3"

FIG. 3G3

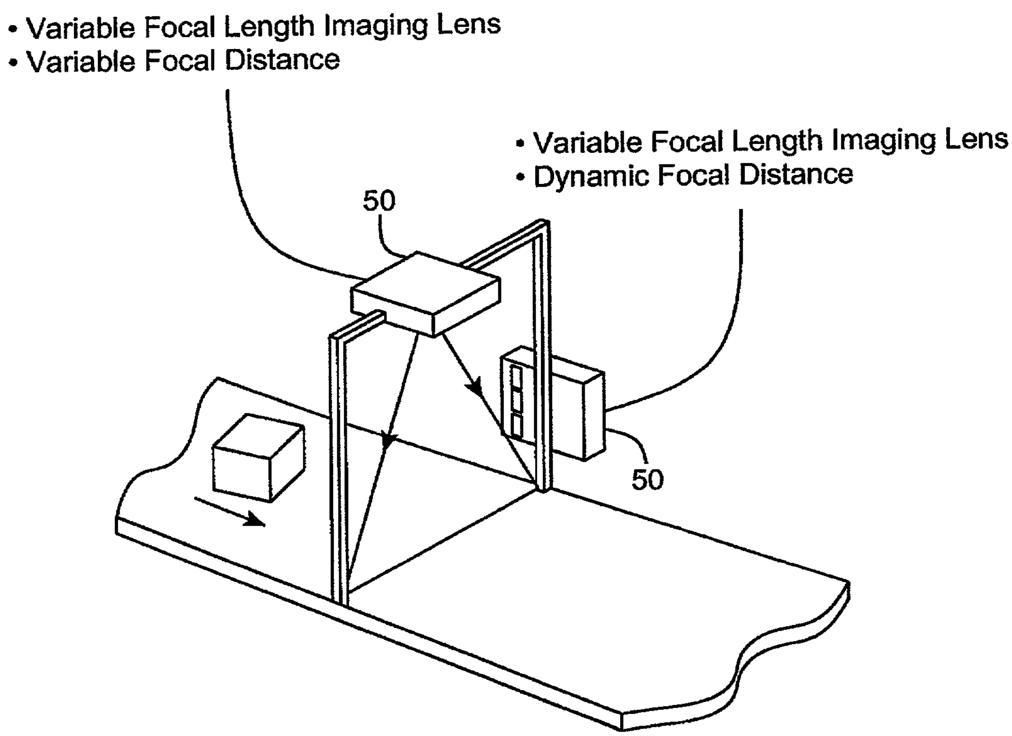

• Variable Focal Length Imaging Lens
• Variable Focal Distance
• Variable Focal Length Imaging Lens
• Dynamic Focal Distance
50
50

FIG. 3H

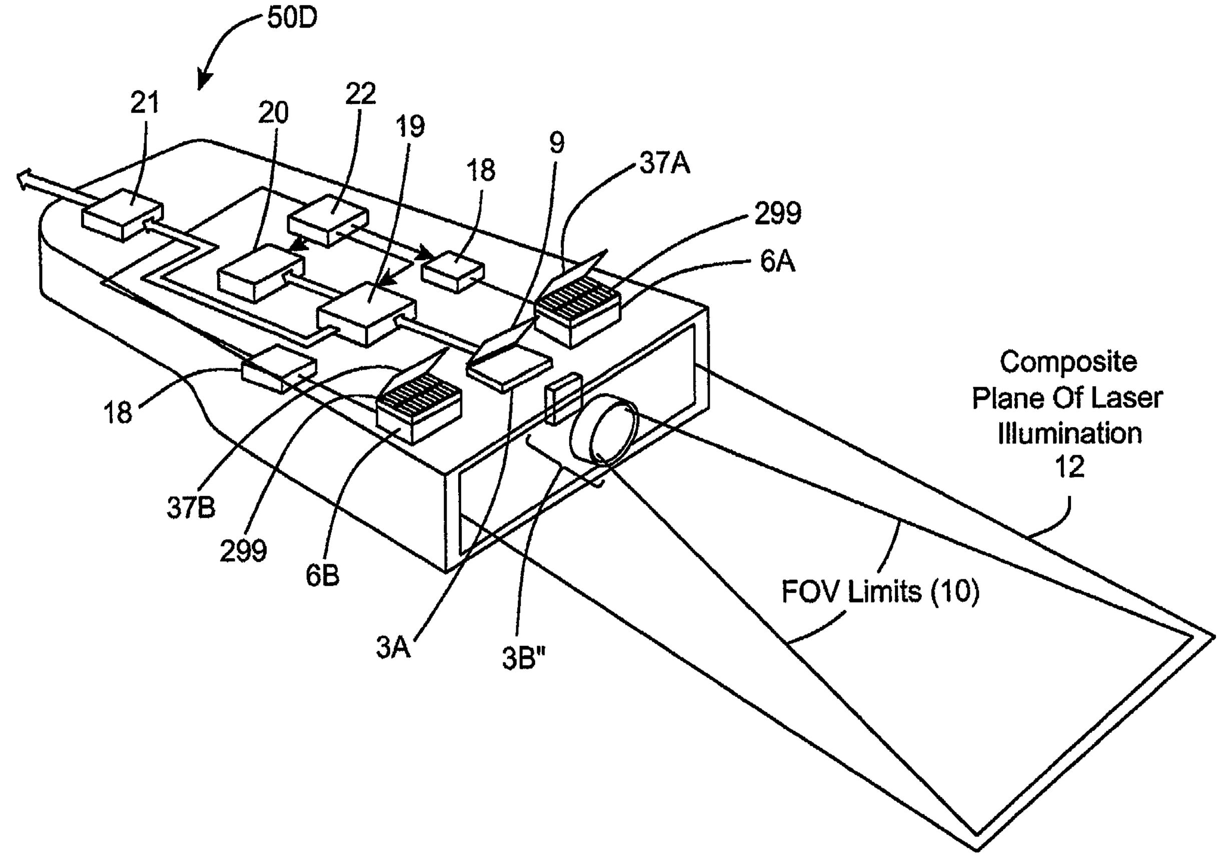

50D
21
20
22
19
18
9
37A
299
6A
18
37B
299
6B
3A
3B"
Composite
Plane Of Laser
Illumination
12
FOV Limits (10)

FIG. 3I

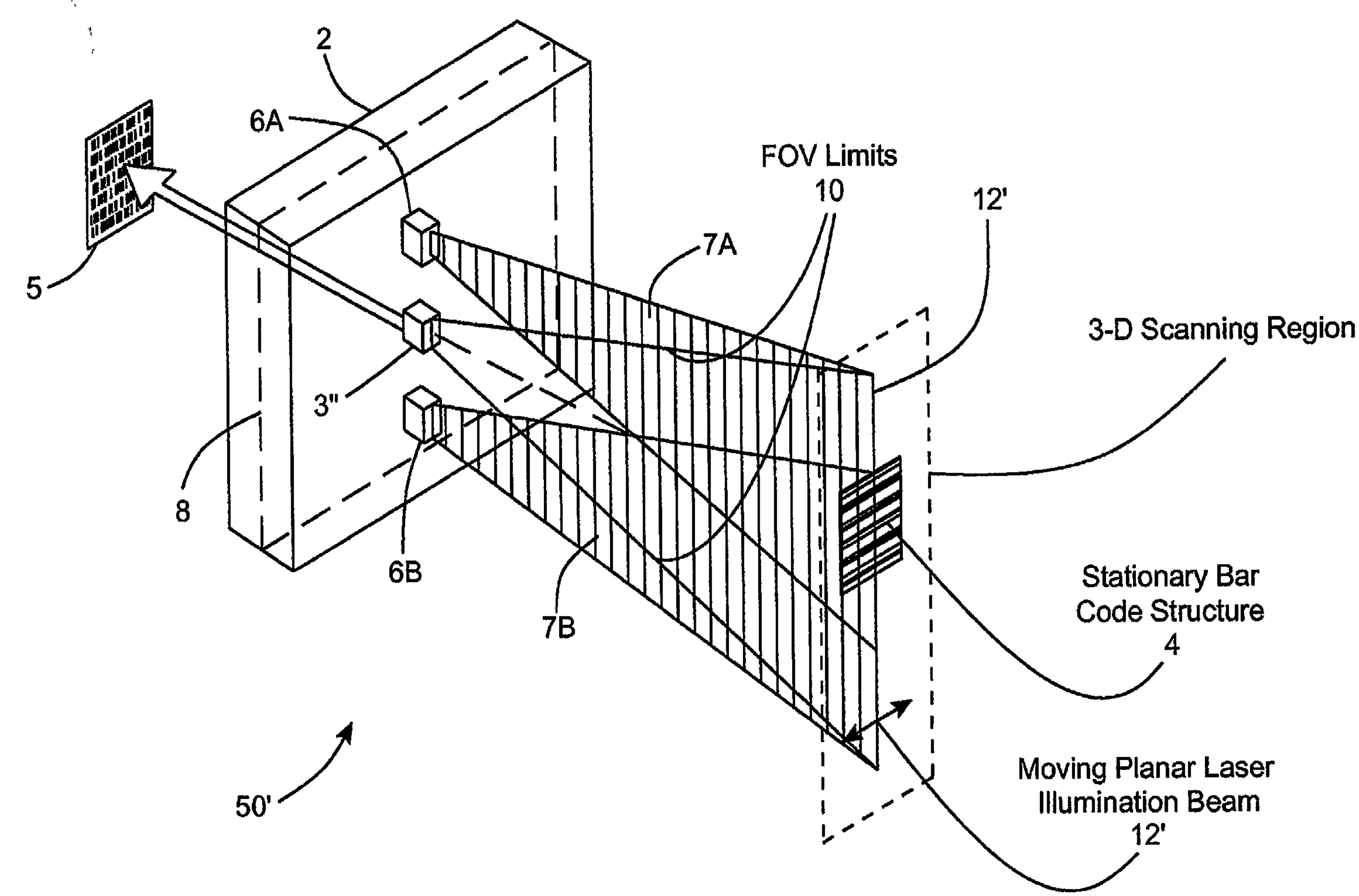

2
6A
FOV Limits
10
12'
7A
5
3-D Scanning Region
3"
8
6B
7B
Stationary Bar
Code Structure
4
50'
Moving Planar Laser
Illumination Beam
12'

FIG. 3J1

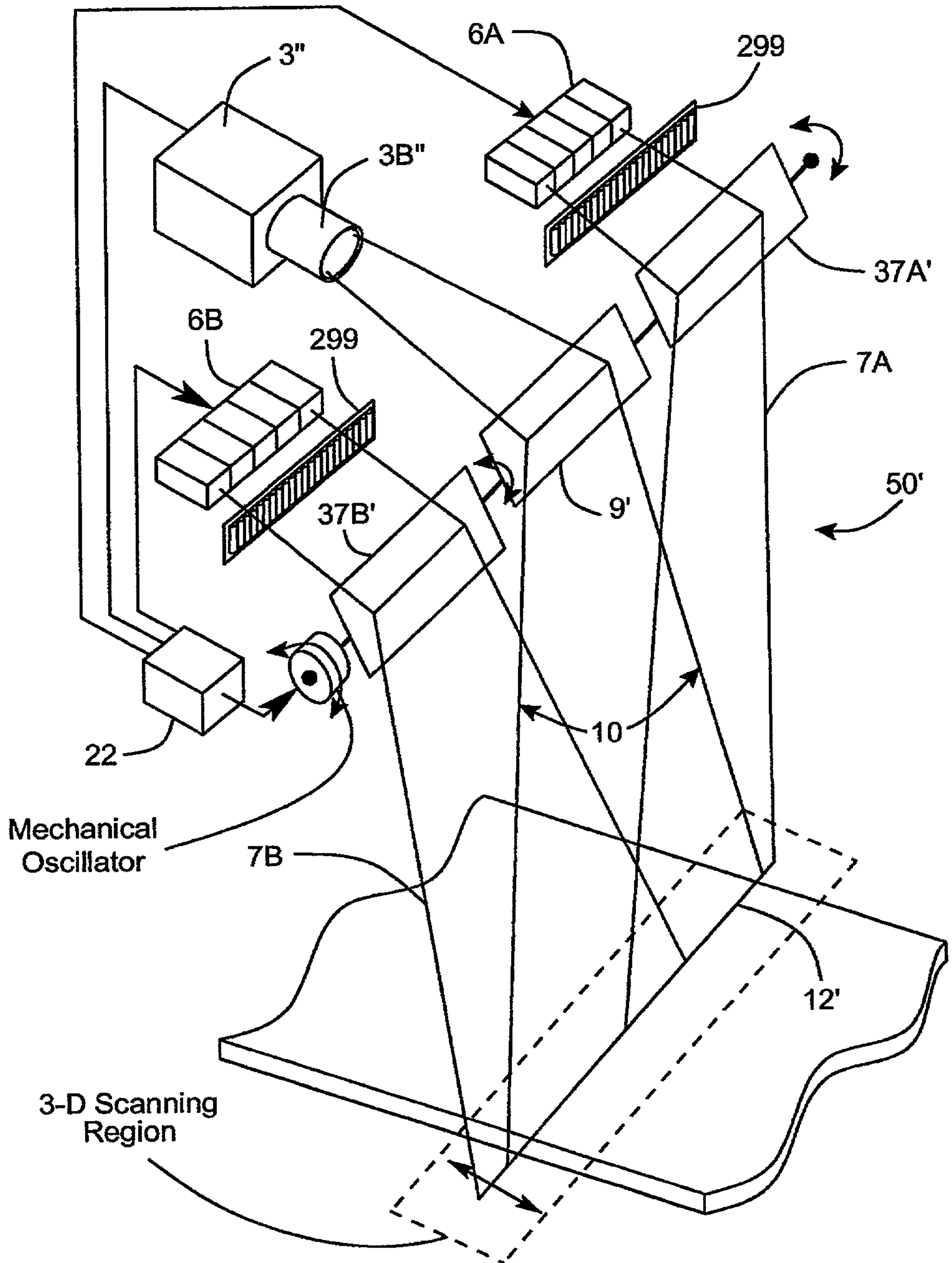

6A
299
3"
3B"
37A'
6B
299
7A
50'
37B'
9'
10
22
Mechanical Oscillator
7B
12'
3-D Scanning Region

FIG. 3J2

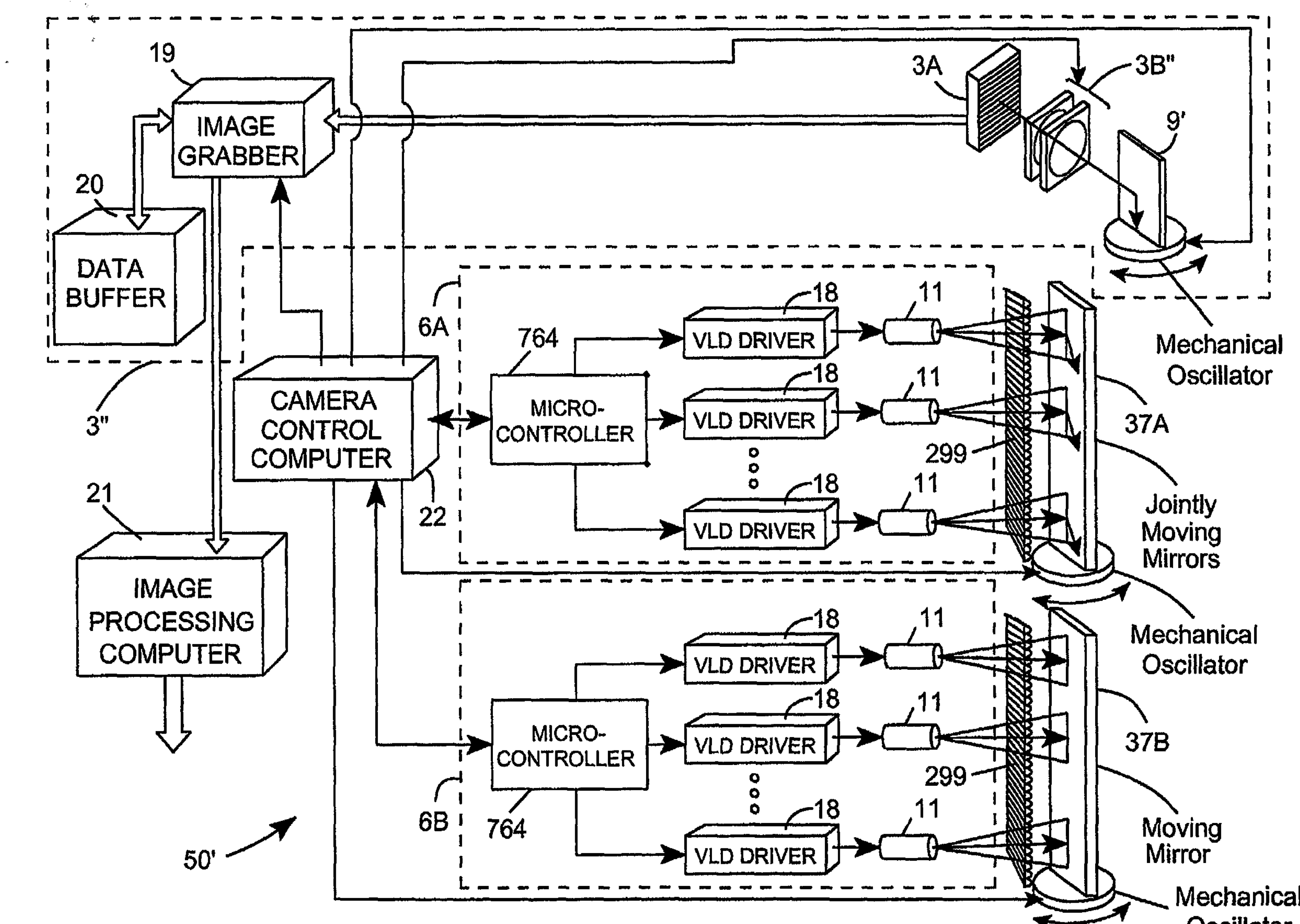

19
IMAGE GRABBER
20
DATA BUFFER
3"
21
IMAGE PROCESSING COMPUTER
CAMERA CONTROL COMPUTER
22
6A
764
MICRO-CONTROLLER
VLD DRIVER
18
11
299
6B
50'
3A
3B"
9'
Mechanical Oscillator
37A
Jointly Moving Mirrors
37B
Moving Mirror

FIG. 3J3

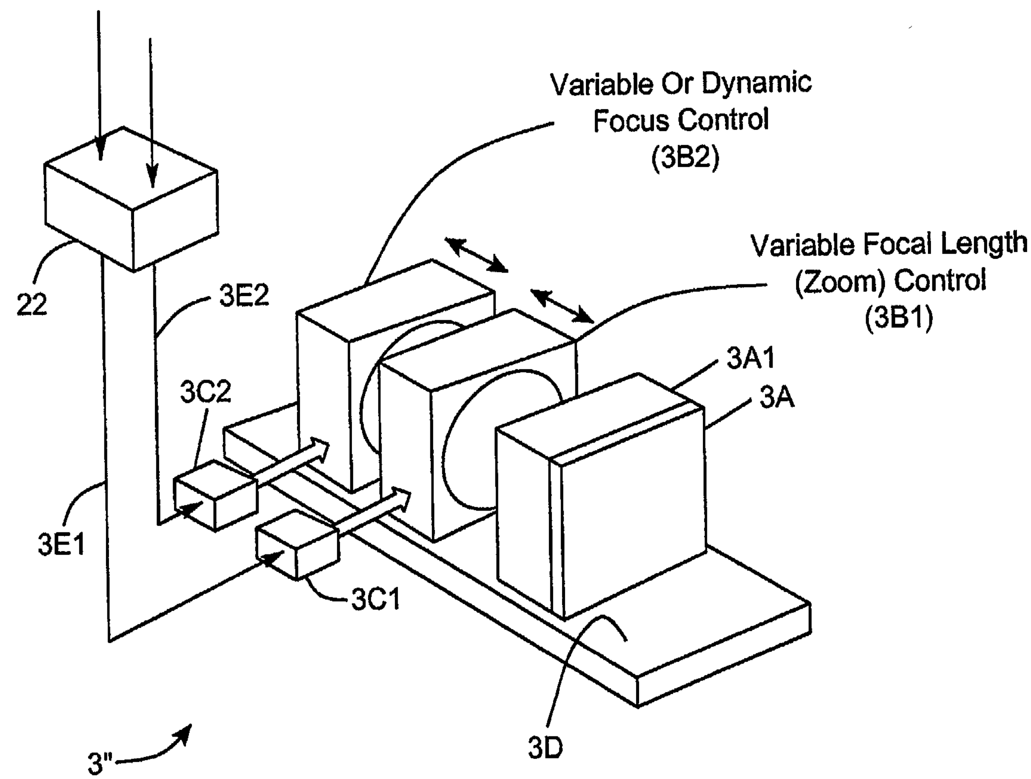
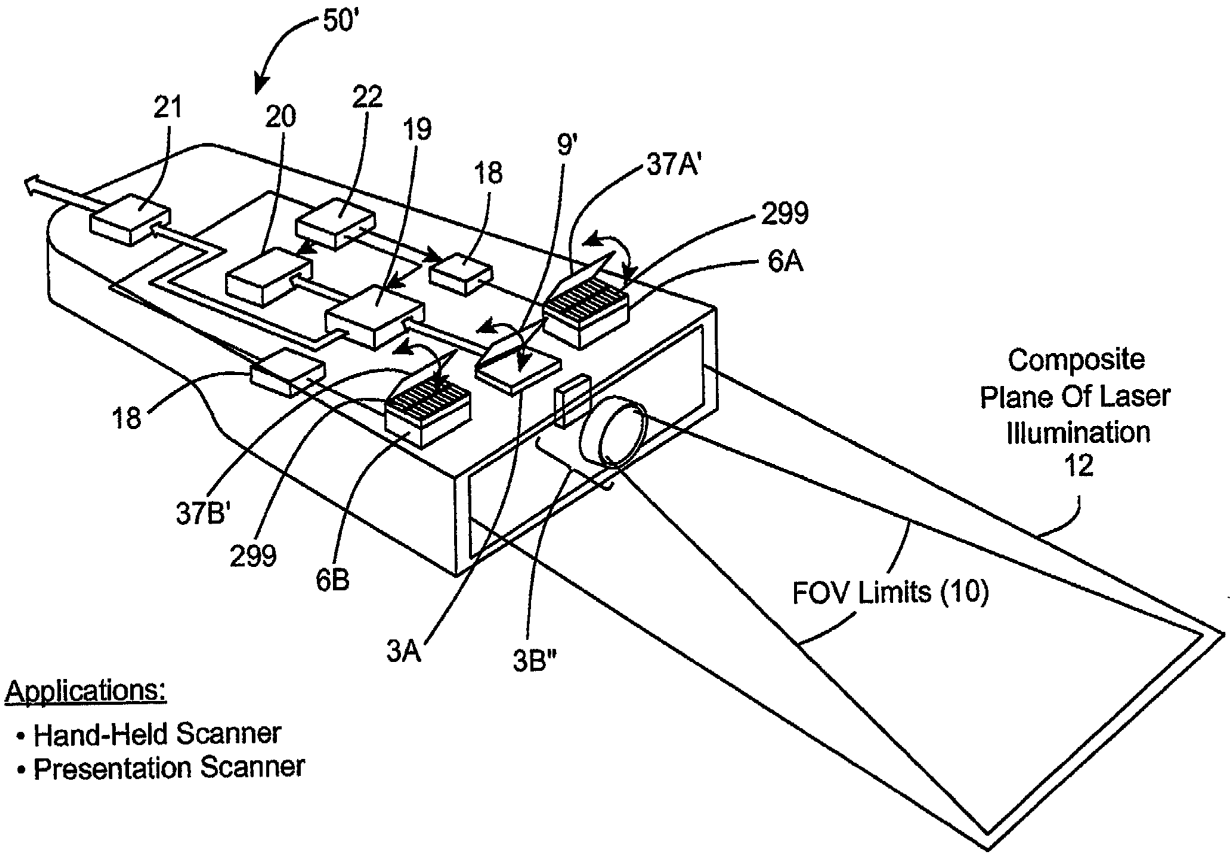

Variable Or Dynamic
Focus Control
(3B2)
Variable Focal Length
(Zoom) Control
(3B1)
22
3E2
3E1
3C2
3C1
3A1
3A
3D
3"

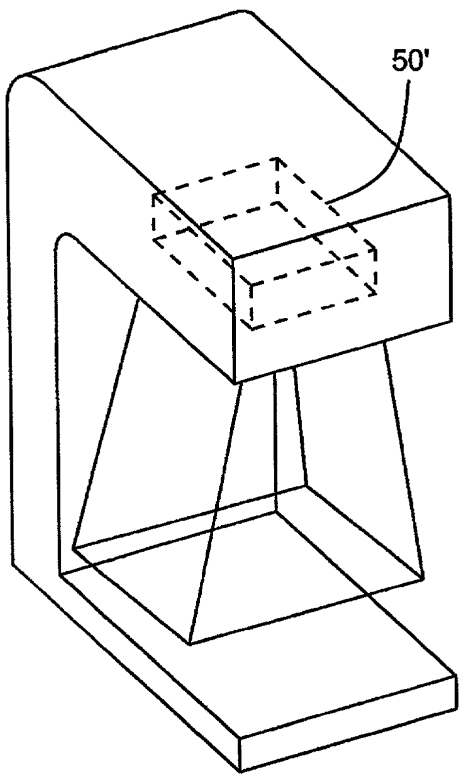
FIG. 3J4



Applications:

- Hand-Held Scanner
- Presentation Scanner

FIG. 3J5



2-D Hold-under Scanner

FIG. 3J6

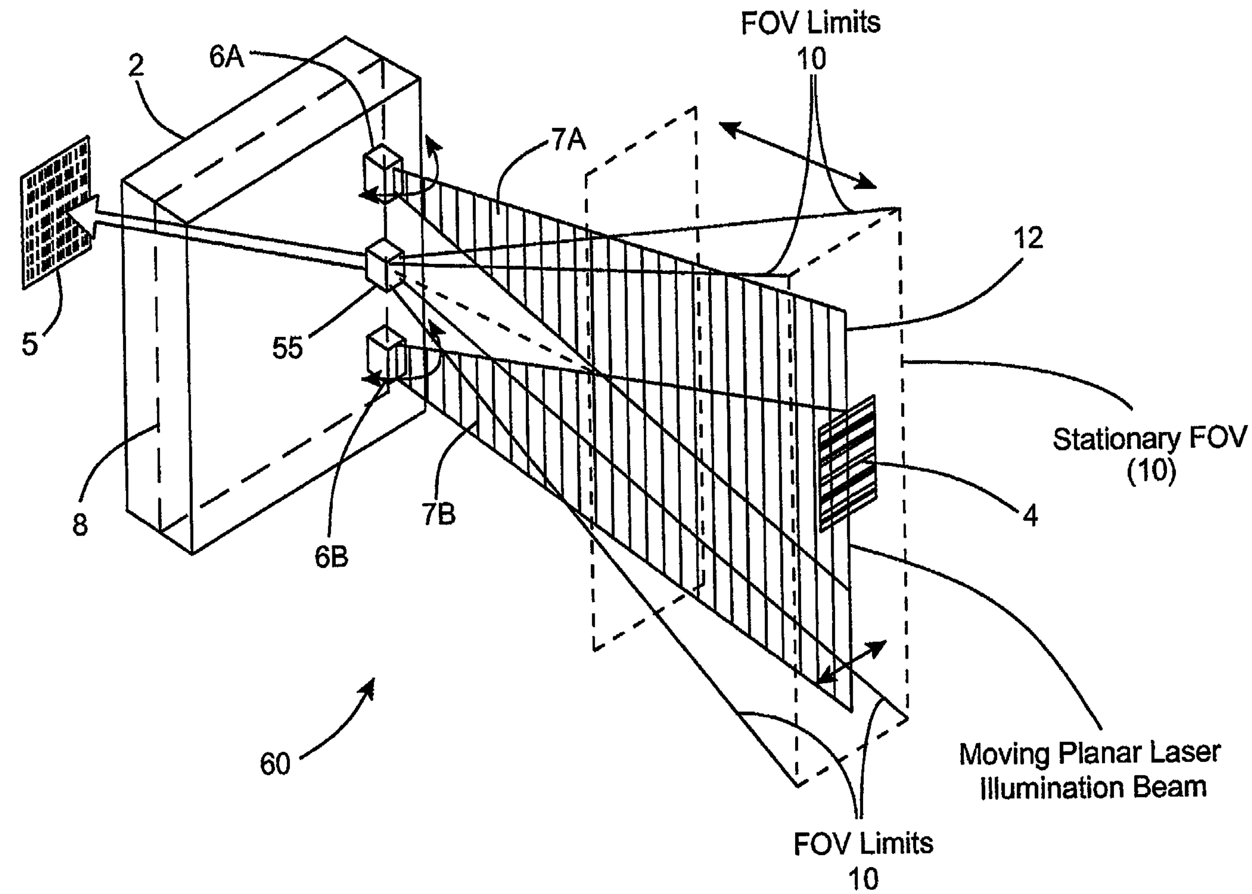

FOV Limits
10
2
6A
7A
12
5
55
Stationary FOV
(10)
8
6B
7B
4
60
Moving Planar Laser
Illumination Beam
FOV Limits
10

FIG. 4A

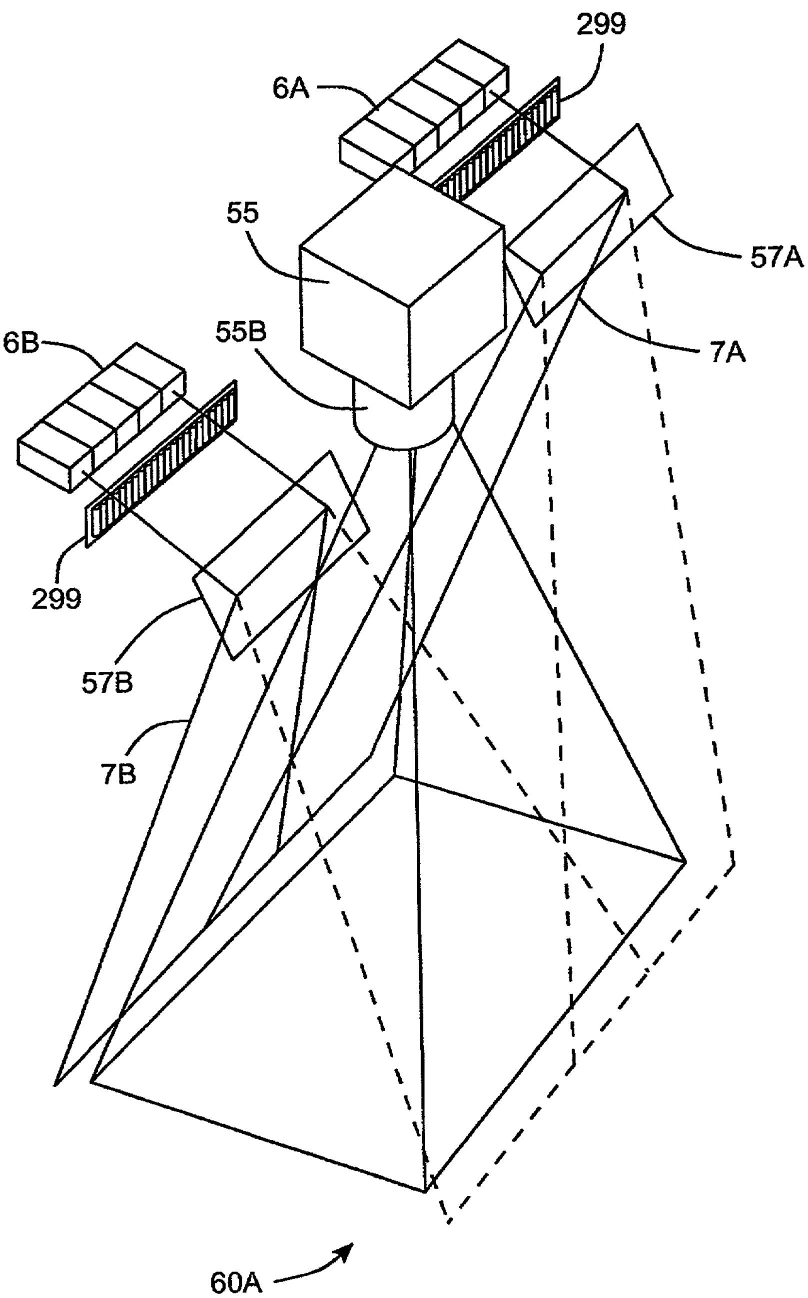
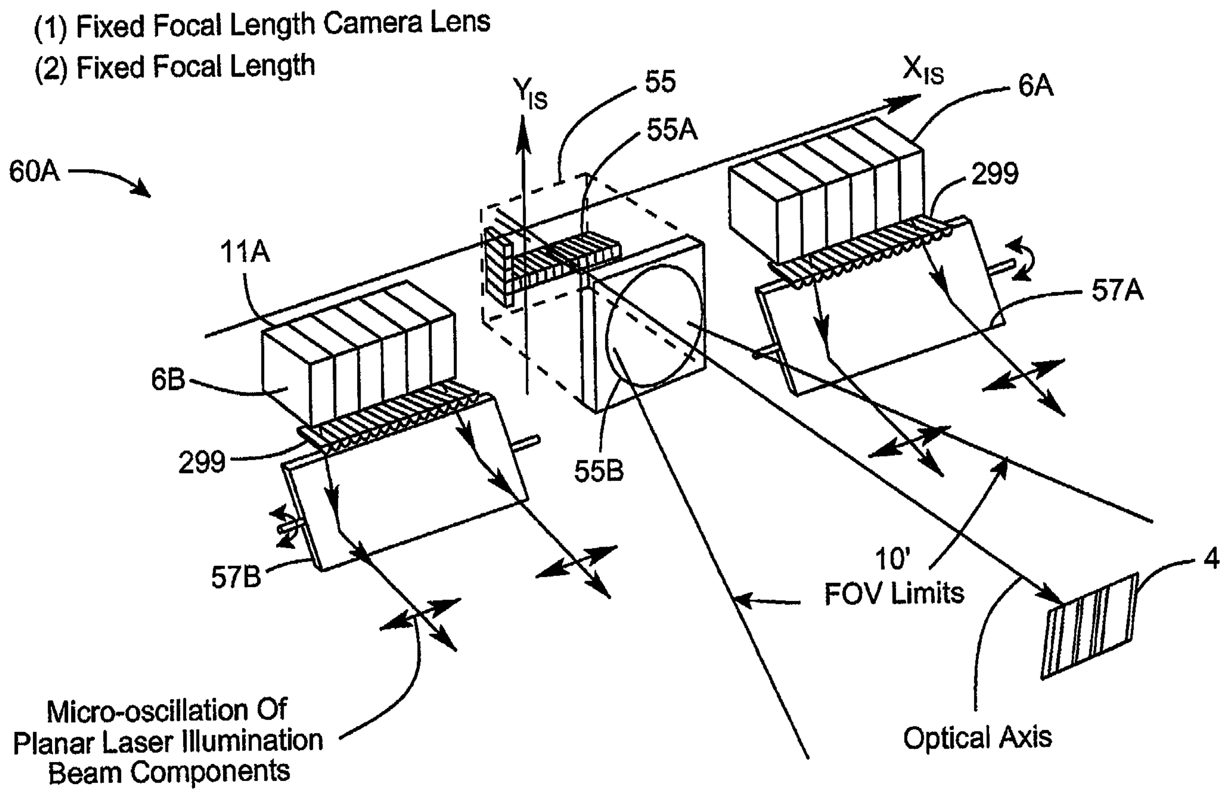
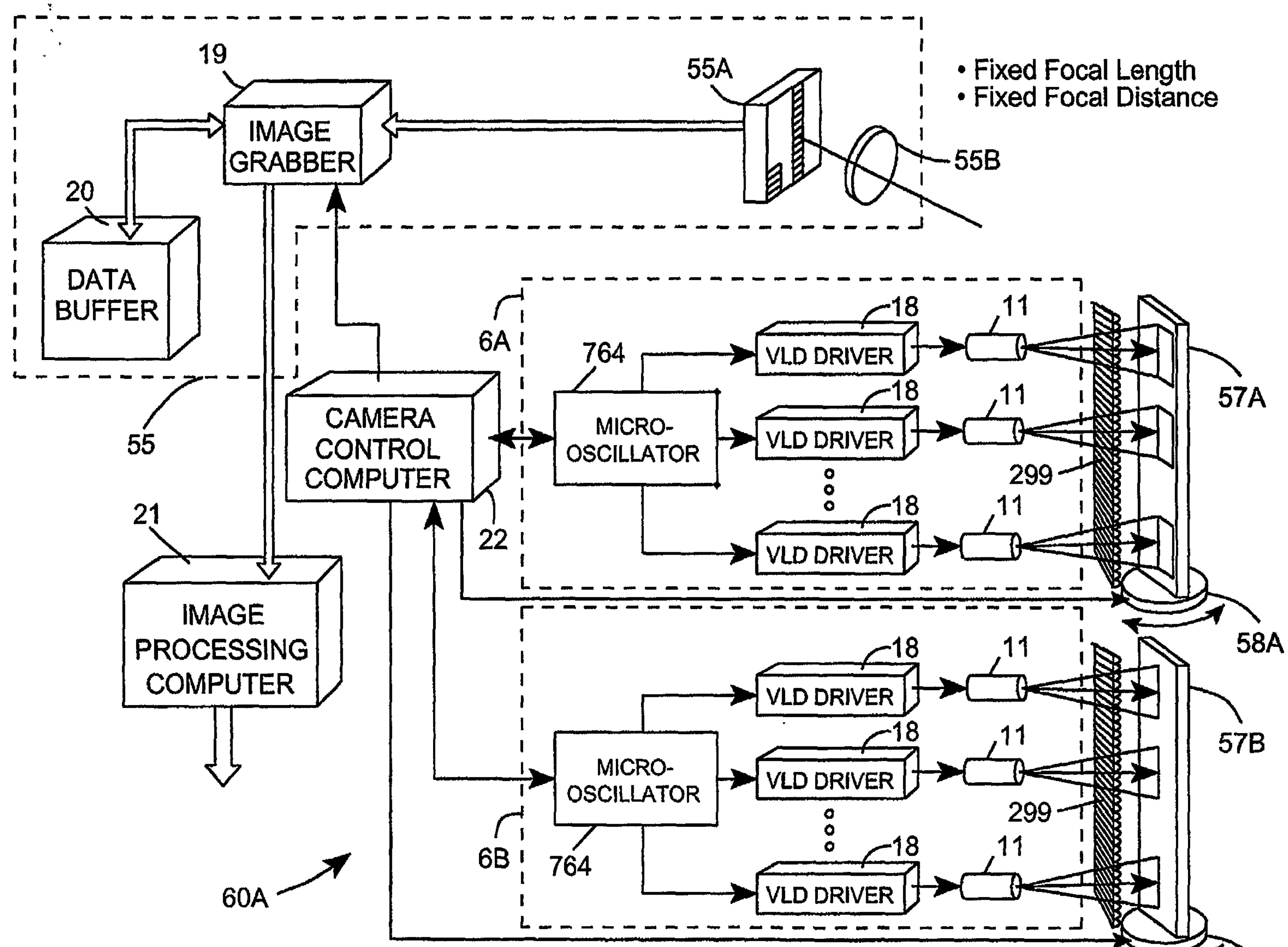


FIG. 4B1



(1) Fixed Focal Length Camera Lens
(2) Fixed Focal Length
60A
11A
6B
299
57B
Y_{IS}
55
55A
55B
X_{IS}
6A
299
57A
10'
FOV Limits
4
Optical Axis
Micro-oscillation Of
Planar Laser Illumination
Beam Components

FIG. 4B2



• Fixed Focal Length
• Fixed Focal Distance
19
IMAGE GRABBER
55A
55B
20
DATA BUFFER
55
CAMERA CONTROL COMPUTER
22
6A
764
MICRO-OSCILLATOR
18
VLD DRIVER
11
299
57A
58A
21
IMAGE PROCESSING COMPUTER
6B
57B
58B
60A

FIG. 4B3

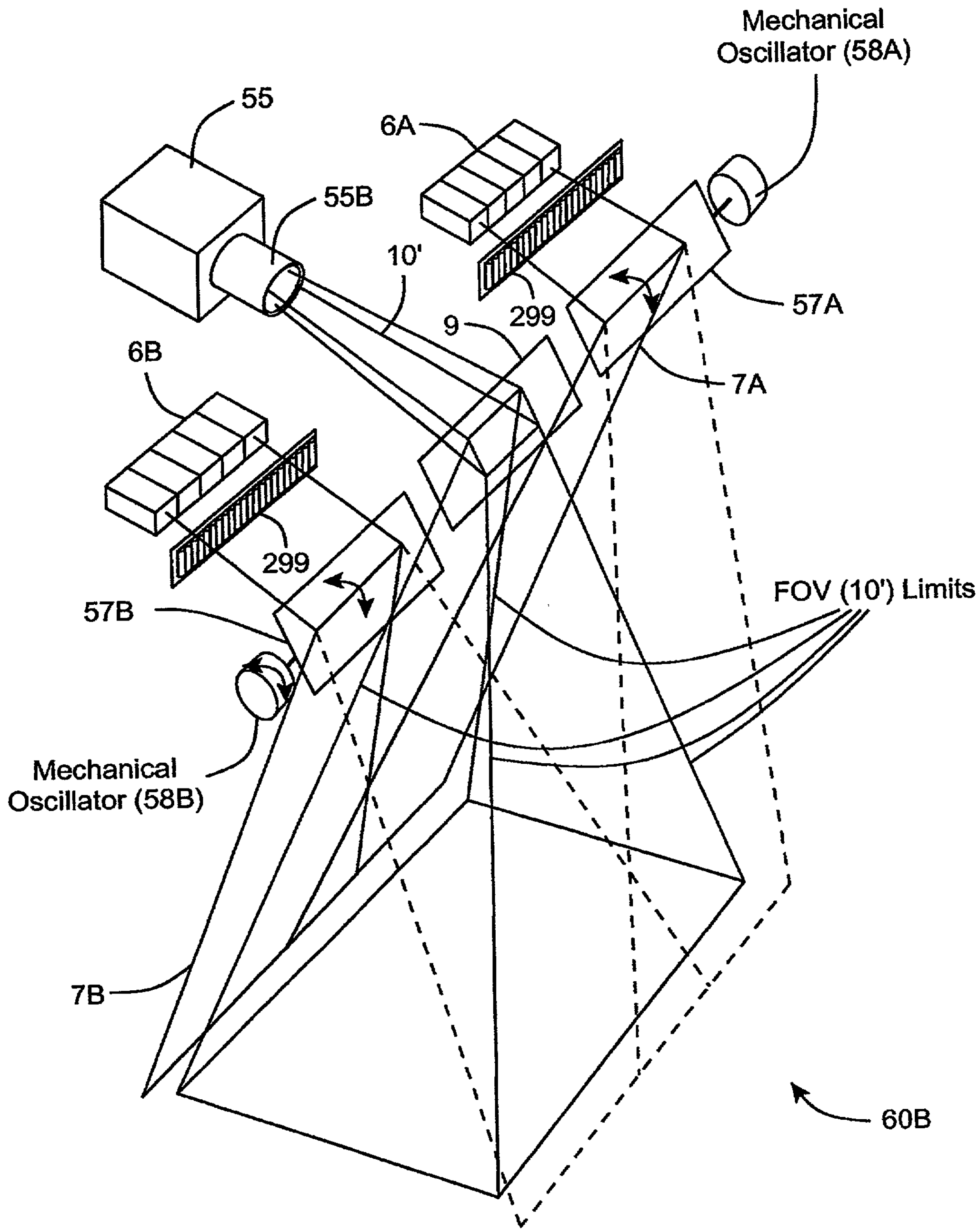

Mechanical
Oscillator (58A)
55
6A
55B
10'
57A
299
9
7A
6B
299
57B
FOV (10') Limits
Mechanical
Oscillator (58B)
7B
60B

FIG. 4C1

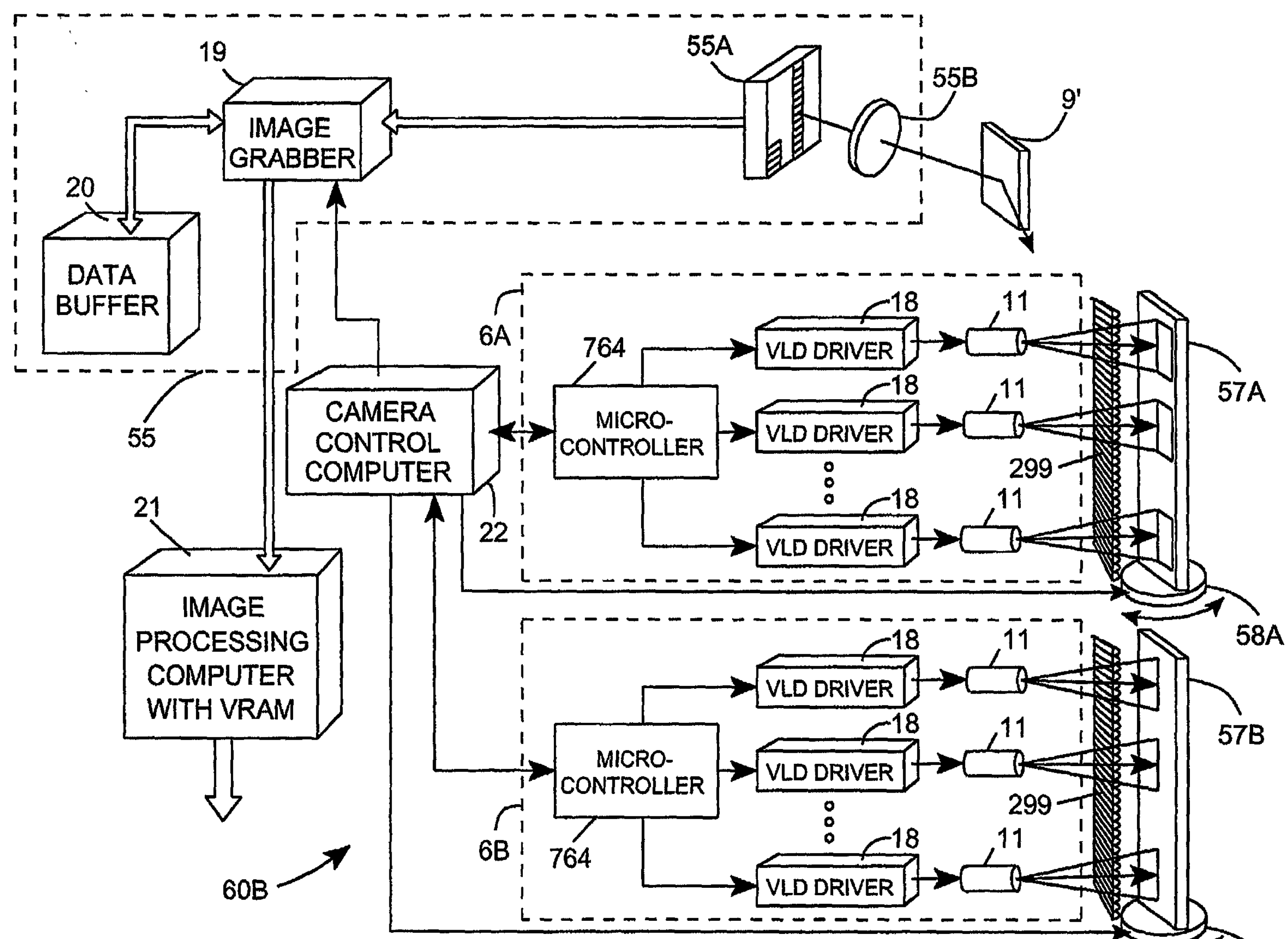
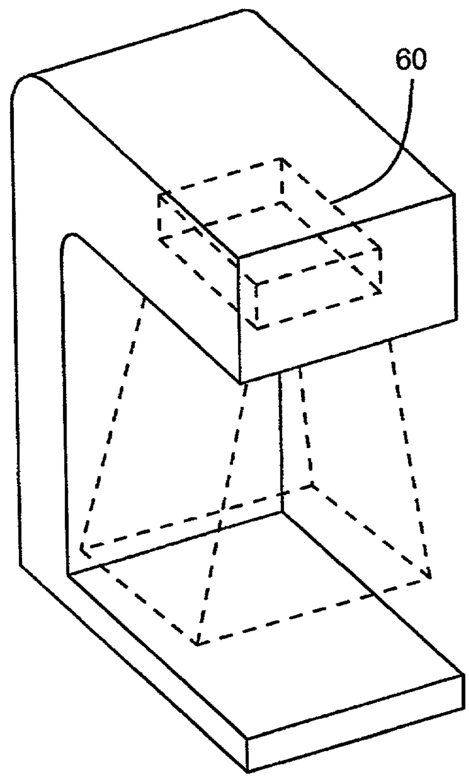

19
IMAGE GRABBER
20
DATA BUFFER
55
55A
55B
9'
21
IMAGE PROCESSING COMPUTER WITH VRAM
CAMERA CONTROL COMPUTER
22
6A
6B
764
MICRO-CONTROLLER
VLD DRIVER
18
11
299
57A
57B
58A
58B
60B

FIG. 4C2



2-D Hold-under Scanner

FIG. 4D

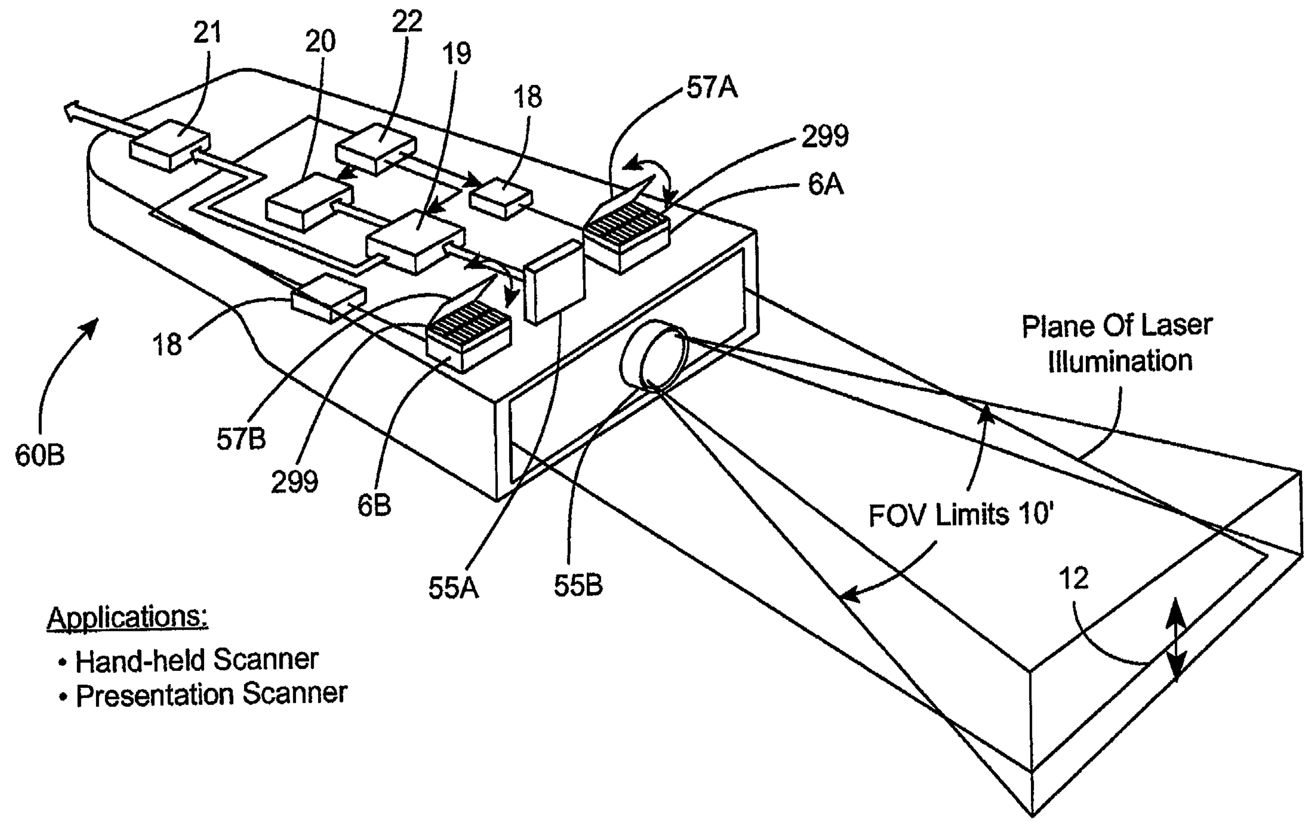

21
20
22
19
18
57A
299
6A
18
60B
57B
299
6B
55A
55B
Plane Of Laser Illumination
FOV Limits 10'
12
Applications:
• Hand-held Scanner
• Presentation Scanner

FIG. 4E

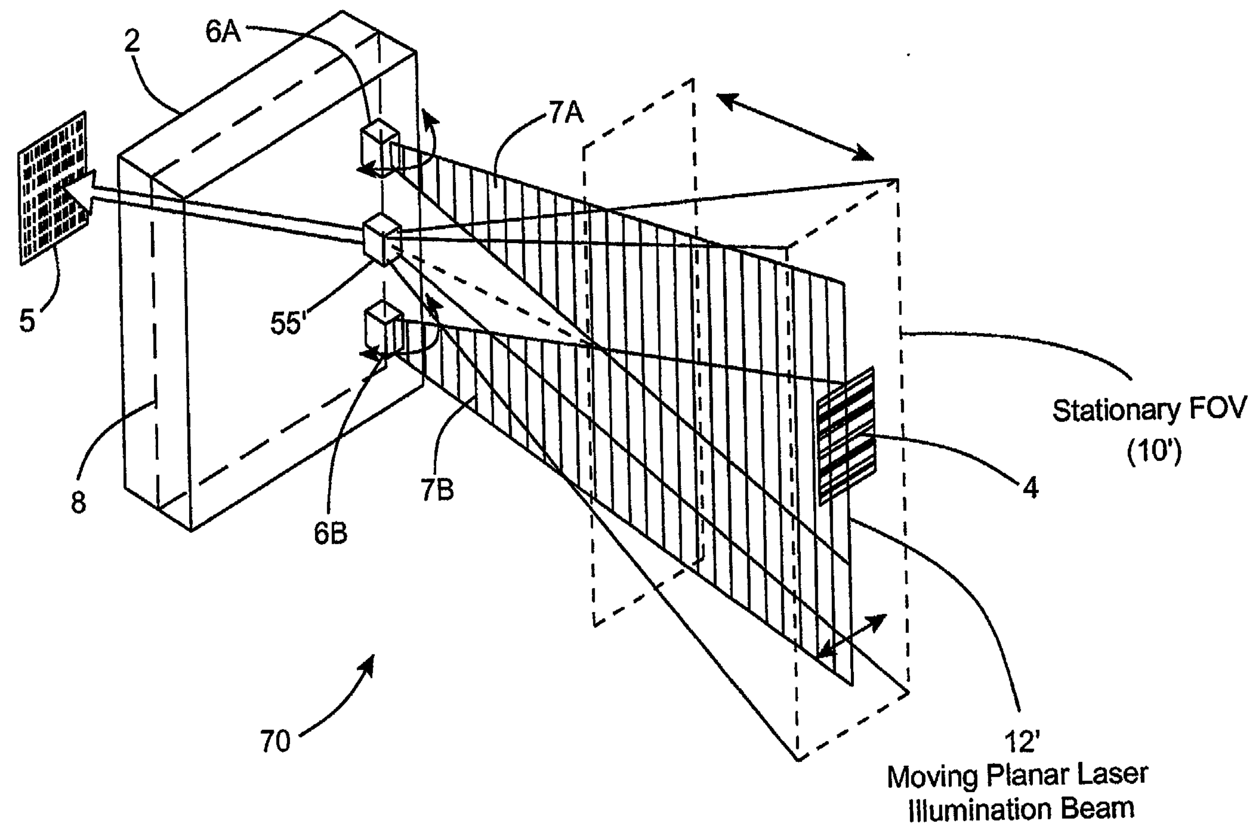

2
6A
7A
5
55'
Stationary FOV
(10')
4
8
6B
7B
70
12'
Moving Planar Laser
Illumination Beam

FIG. 5A

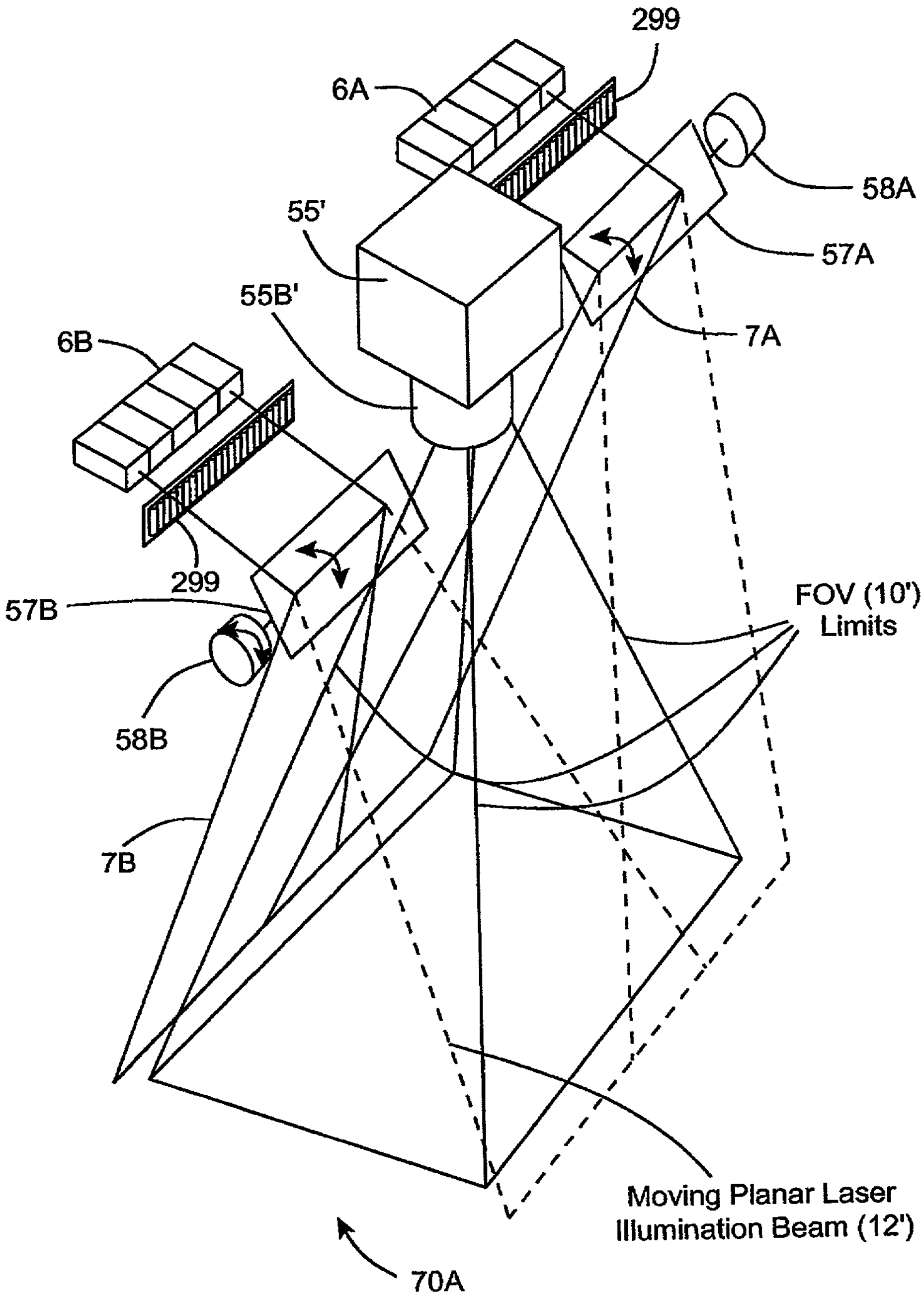
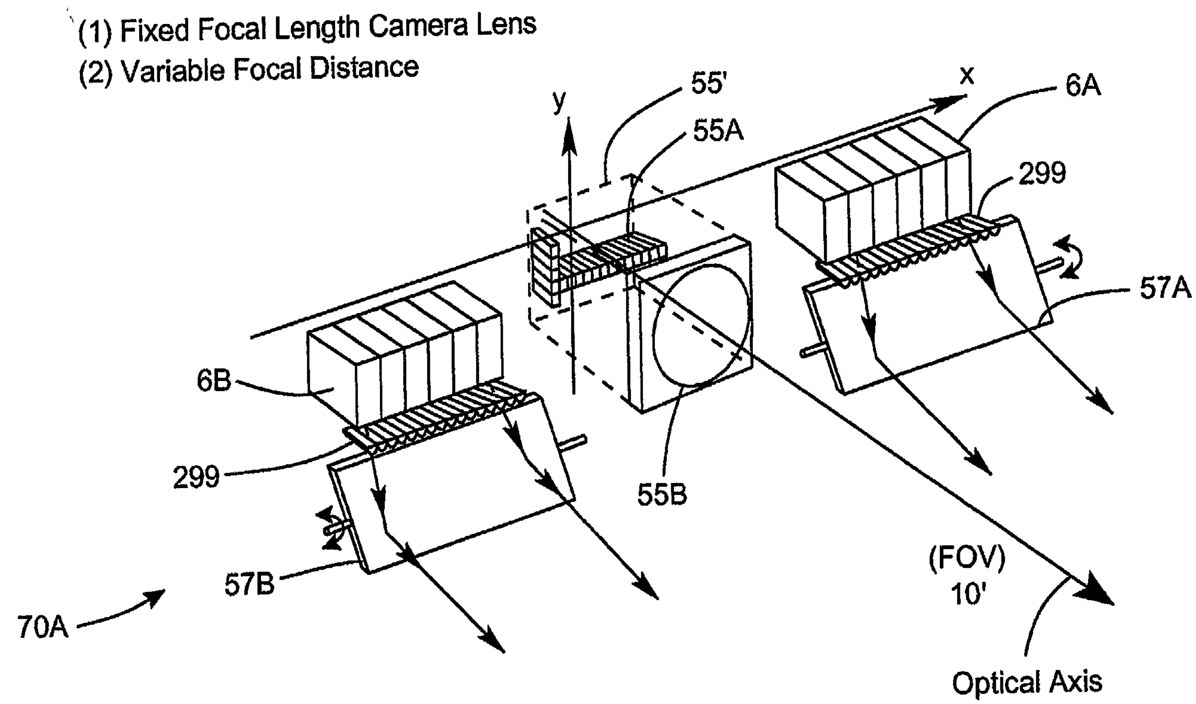
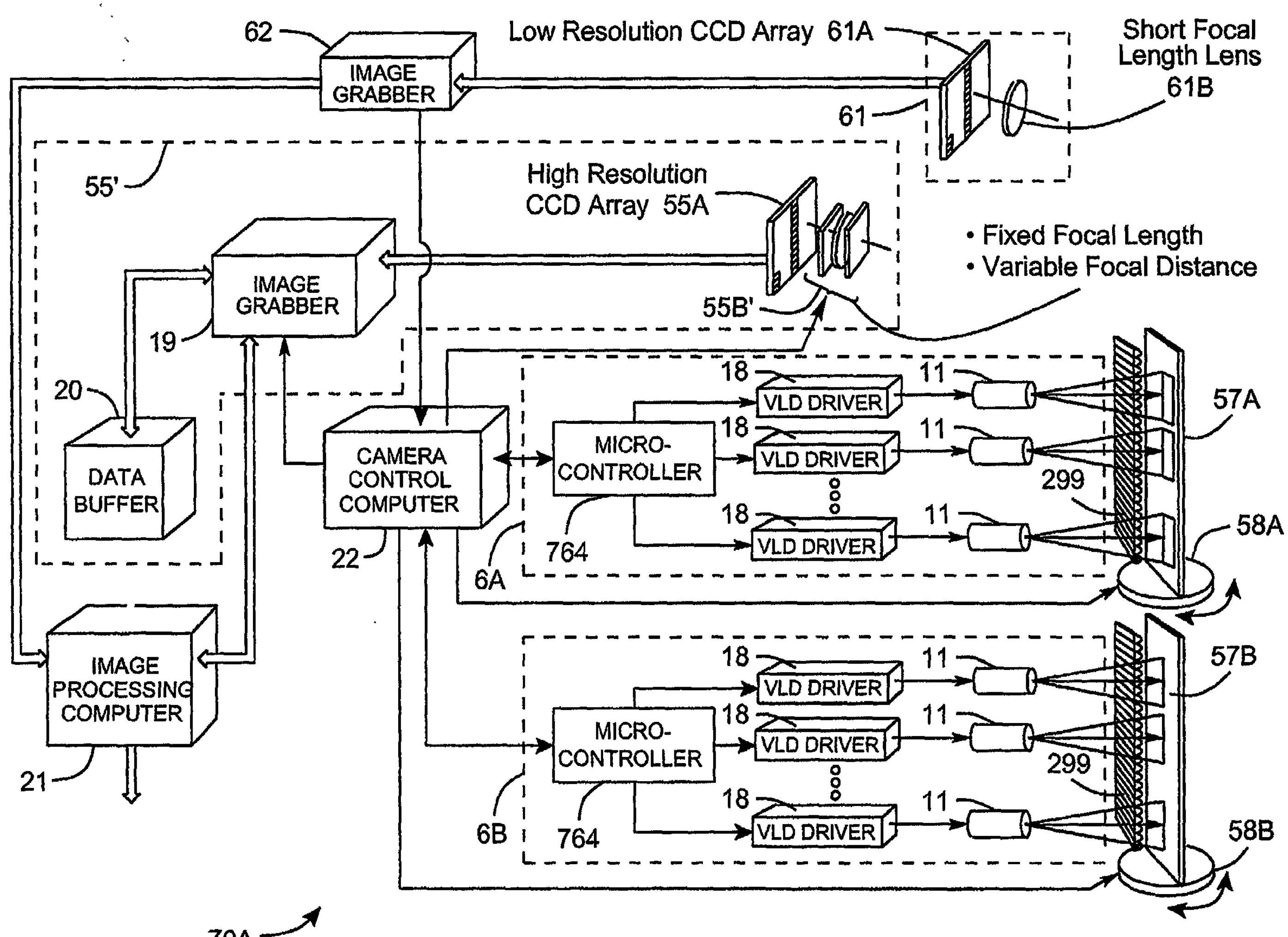

299
6A
58A
55'
57A
55B'
7A
6B
299
FOV (10')
Limits
57B
58B
7B
Moving Planar Laser
Illumination Beam (12')
70A

FIG. 5B1



(1) Fixed Focal Length Camera Lens
(2) Variable Focal Distance
y
x
55'
55A
6A
299
57A
6B
299
55B
57B
70A
(FOV)
10'
Optical Axis

FIG. 5B2



62
IMAGE GRABBER
Low Resolution CCD Array 61A
Short Focal Length Lens 61B
61
55'
High Resolution CCD Array 55A
• Fixed Focal Length
• Variable Focal Distance
IMAGE GRABBER
19
55B'
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
764
6A
18
VLD DRIVER
11
57A
299
58A
IMAGE PROCESSING COMPUTER
21
MICRO-CONTROLLER
764
6B
57B
58B
70A

FIG. 5B3

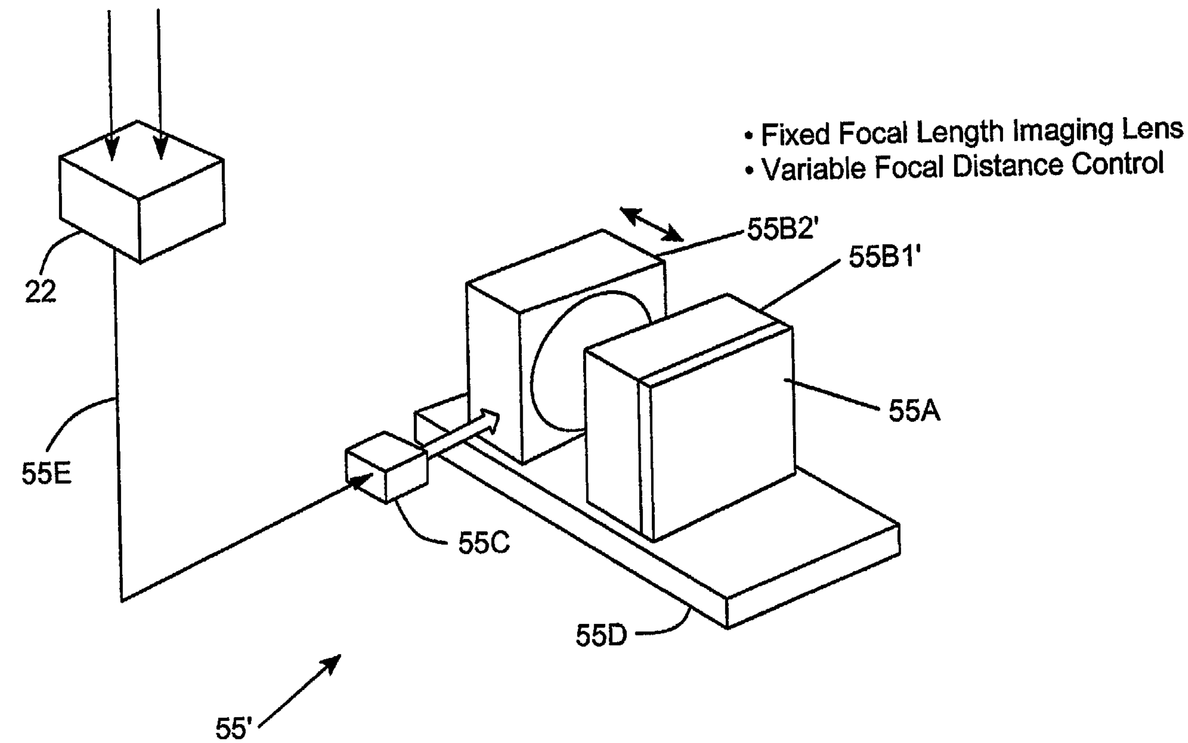
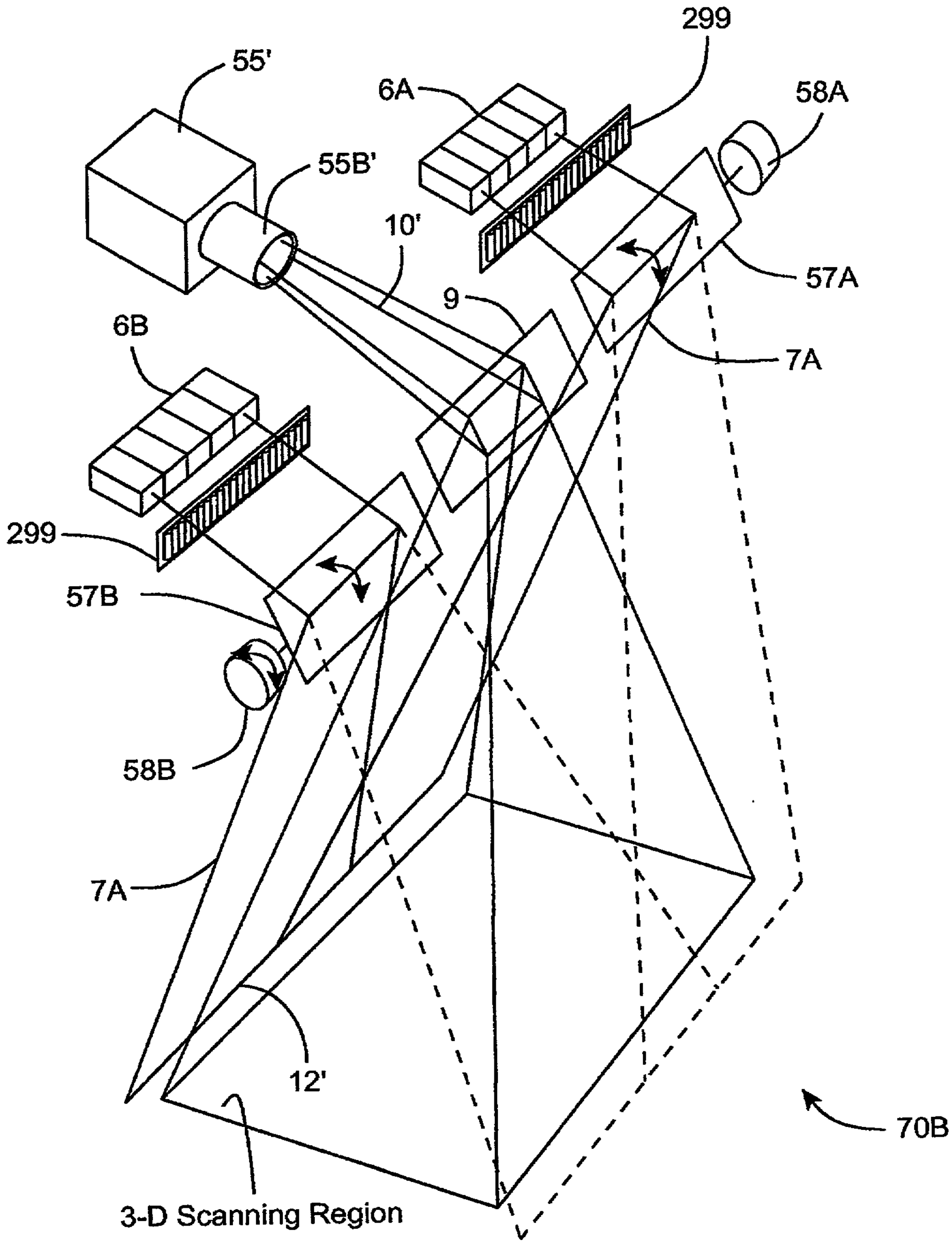

• Fixed Focal Length Imaging Lens
• Variable Focal Distance Control
55B2'
55B1'
55A
22
55E
55C
55D
55'

FIG. 5B4



55'
299
6A
58A
55B'
10'
57A
9
6B
7A
299
57B
58B
7A
12'
70B
3-D Scanning Region

FIG. 5C1

(1) Variable Focal Length Camera Lens
(2) Fixed Focal Distance

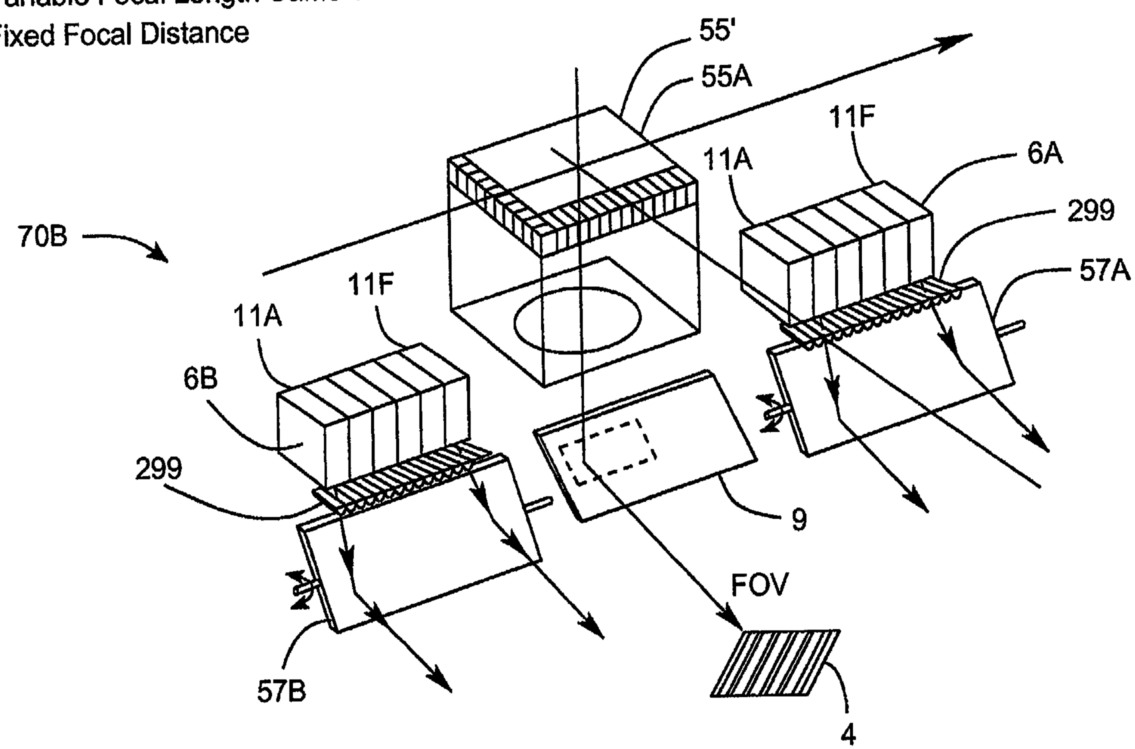


FIG. 5C2

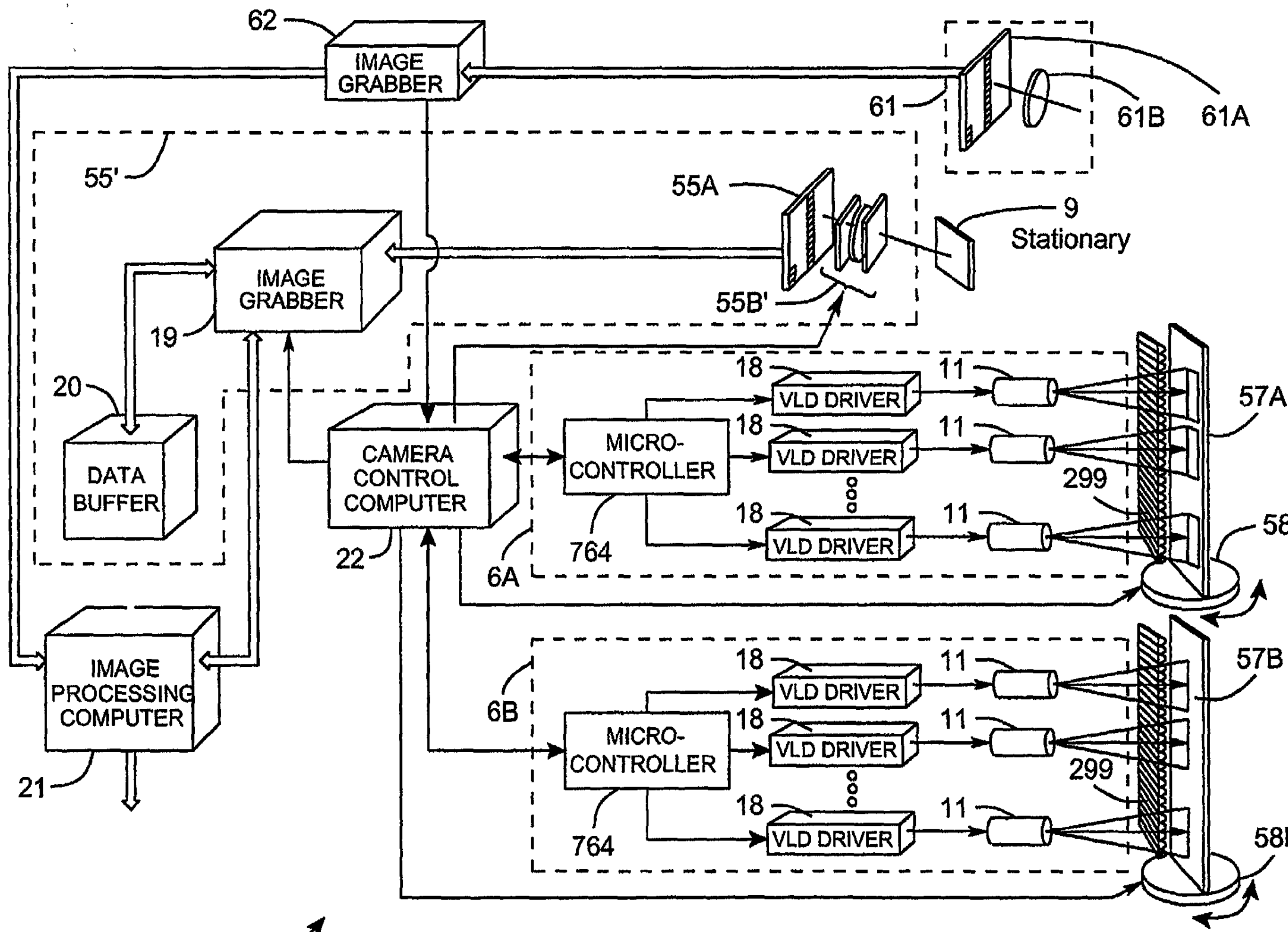

62
IMAGE GRABBER
61
61B
61A
55'
55A
9
Stationary
IMAGE GRABBER
19
55B'
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
18
VLD DRIVER
11
MICRO-CONTROLLER
764
6A
299
57A
58A
IMAGE PROCESSING COMPUTER
21
6B
57B
58B
70B

FIG. 5C3

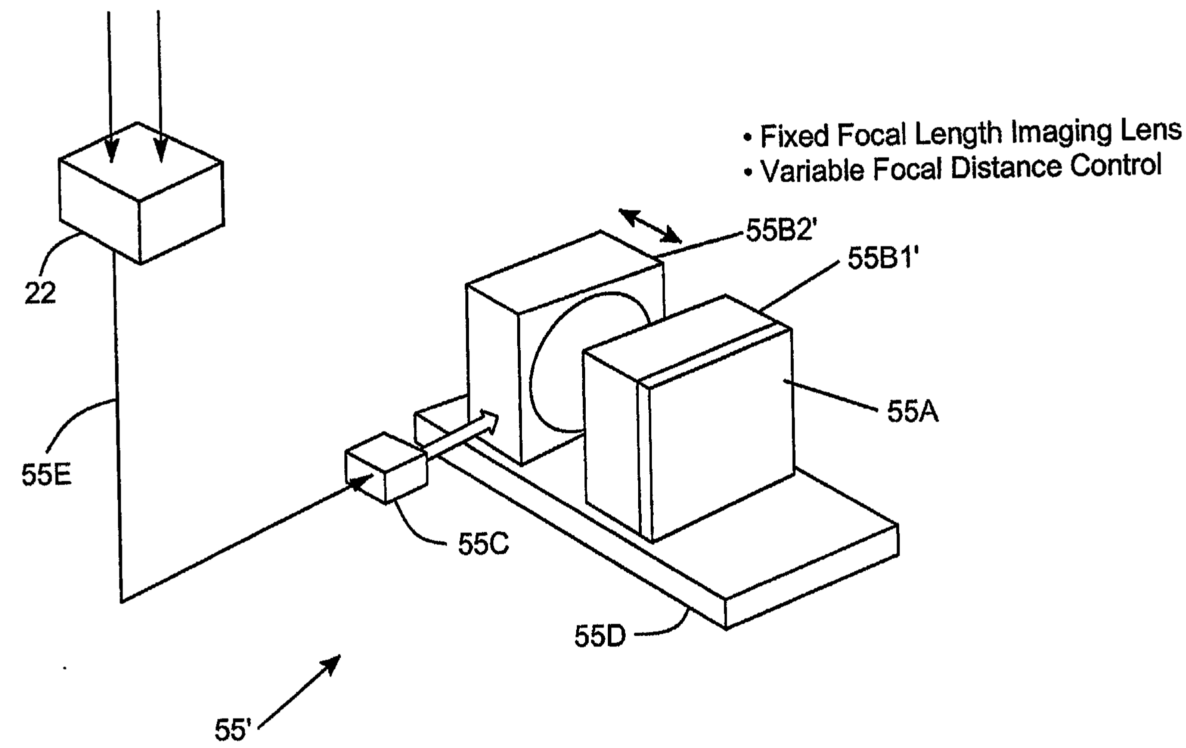

• Fixed Focal Length Imaging Lens
• Variable Focal Distance Control
55B2'
55B1'
55A
22
55E
55C
55D
55'

FIG. 5C4

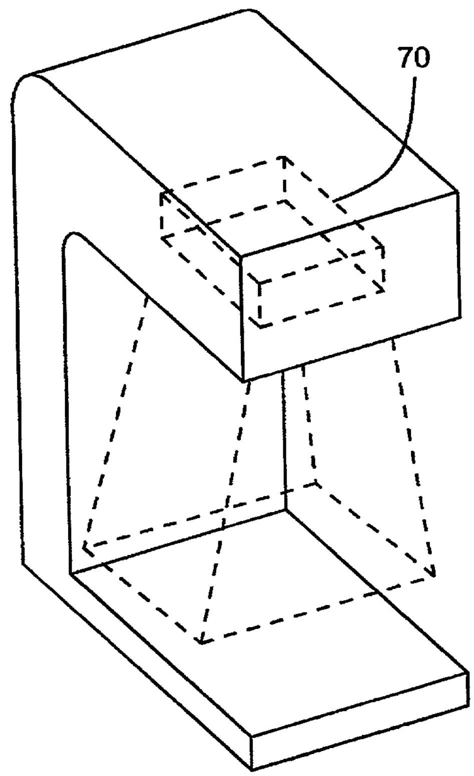


FIG. 5D

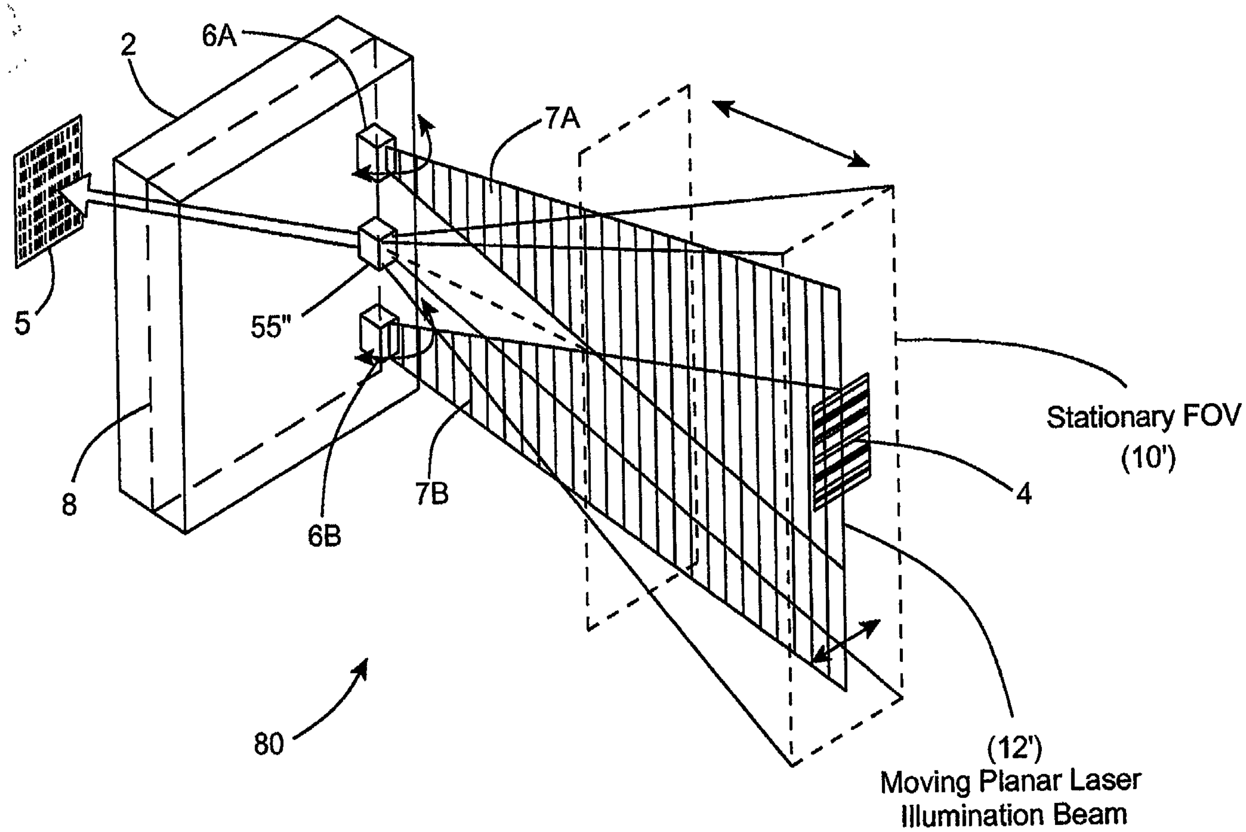

2
6A
7A
5
55"
8
6B
7B
Stationary FOV
(10')
4
80
(12')
Moving Planar Laser
Illumination Beam

FIG. 6A

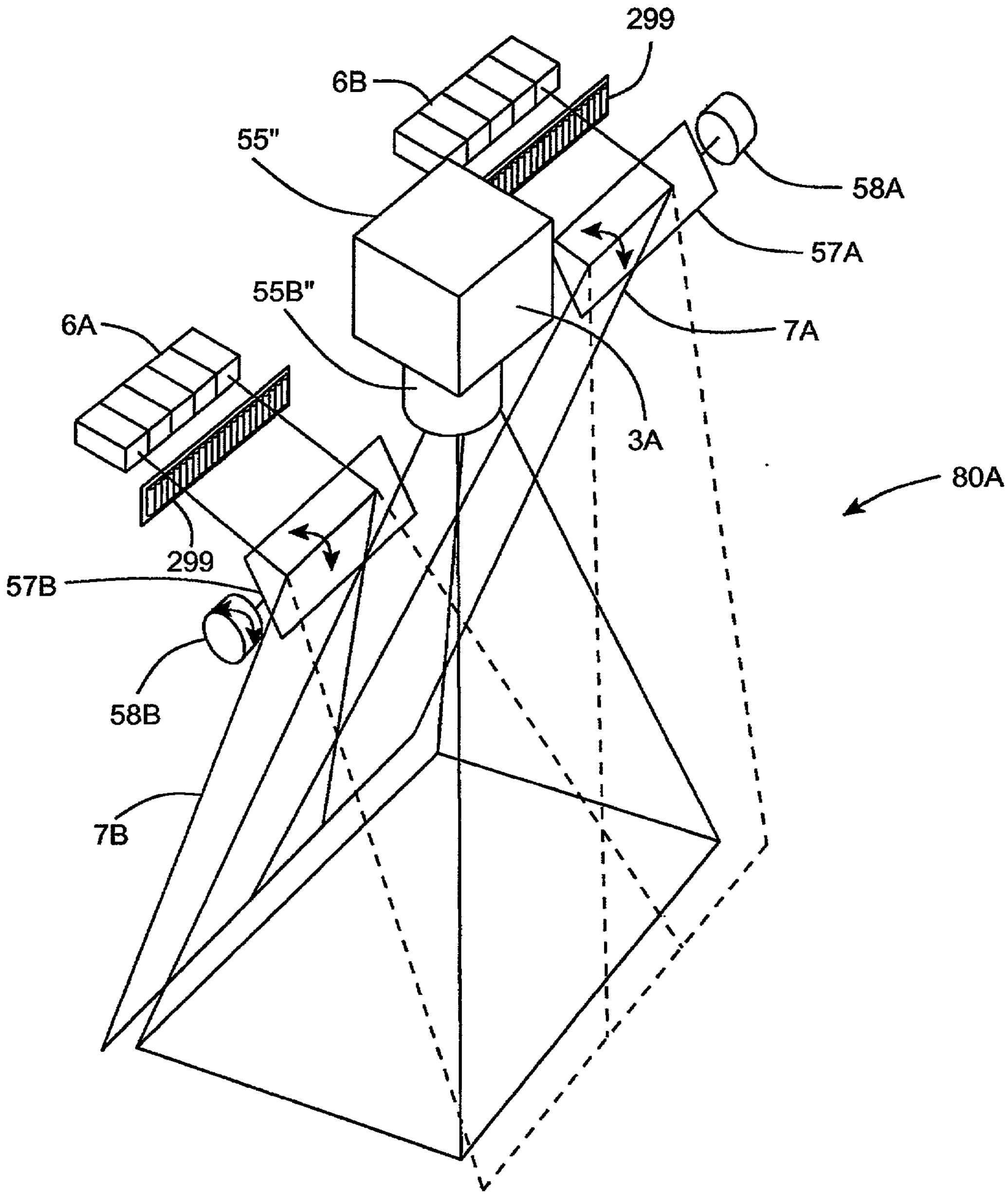


FIG. 6B1

(1) Variable Focal Length Camera Lens
(2) Variable Focal Distance

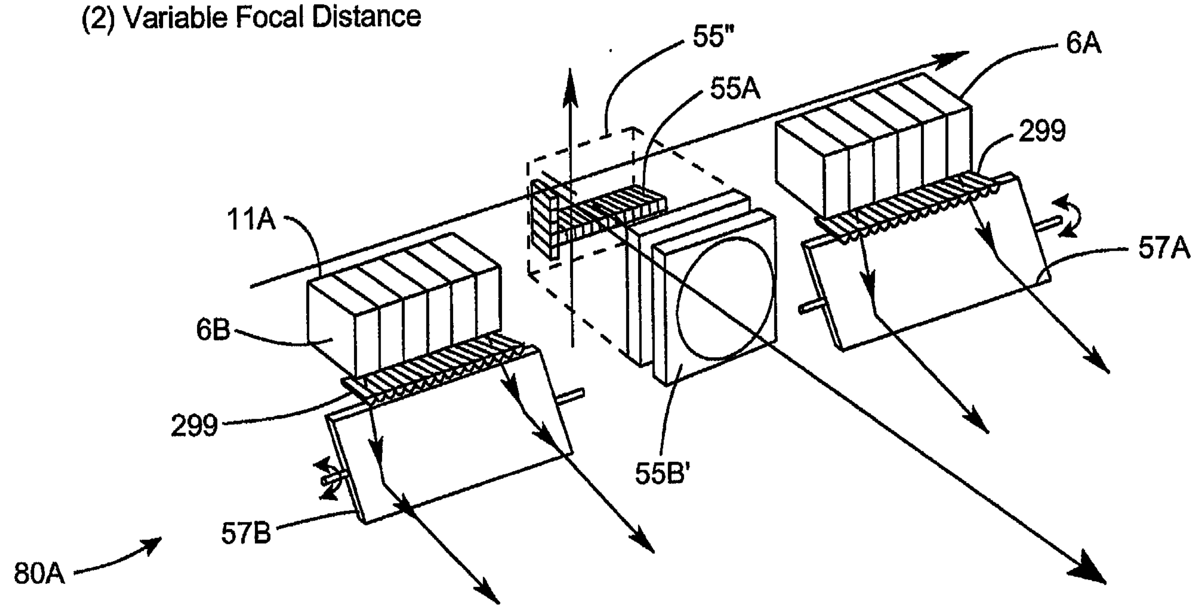


FIG. 6B2

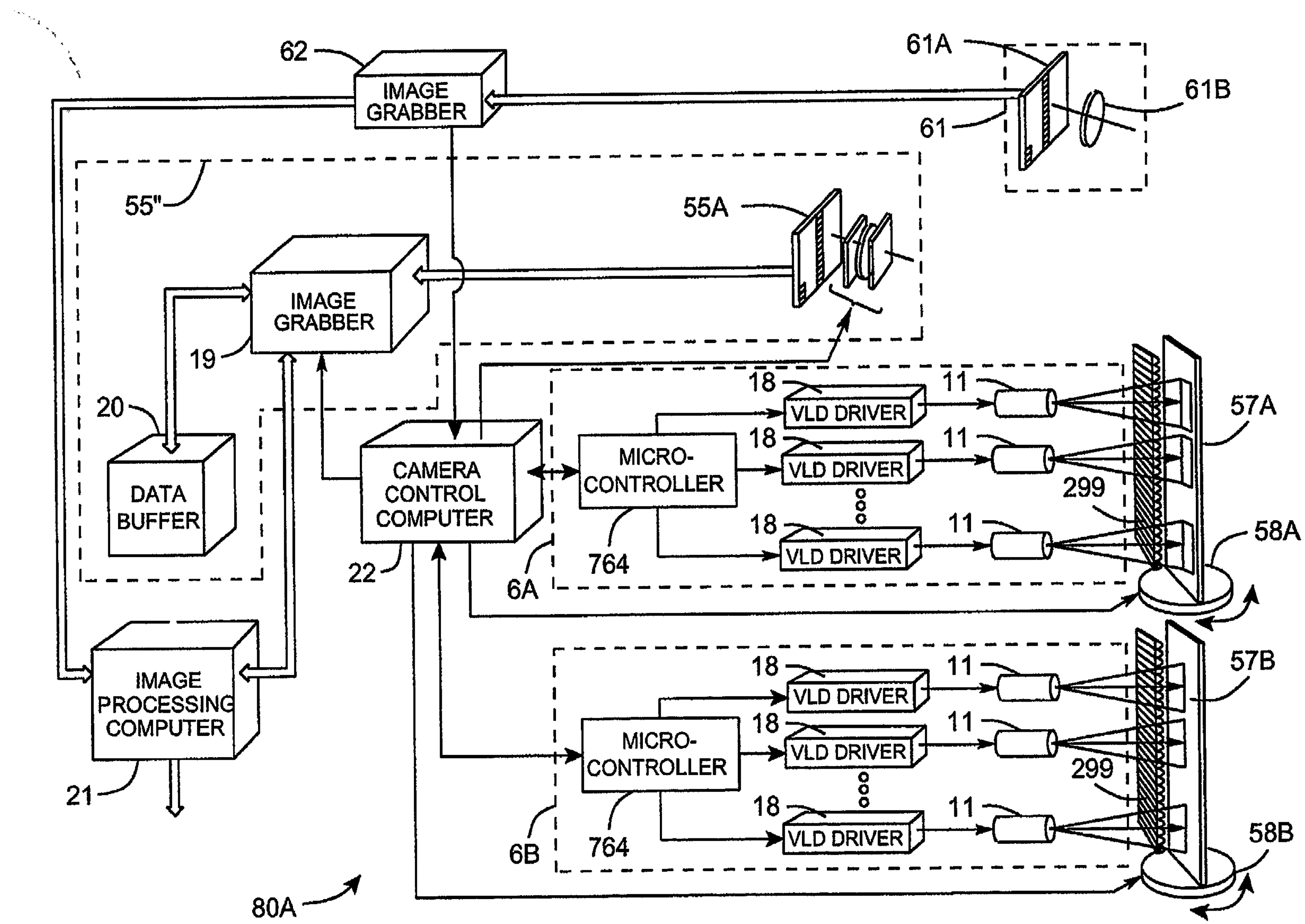

62
IMAGE GRABBER
61A
61B
61
55"
55A
IMAGE GRABBER
19
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
764
6A
18
VLD DRIVER
11
299
57A
58A
IMAGE PROCESSING COMPUTER
21
MICRO-CONTROLLER
764
6B
57B
58B
80A

FIG. 6B3

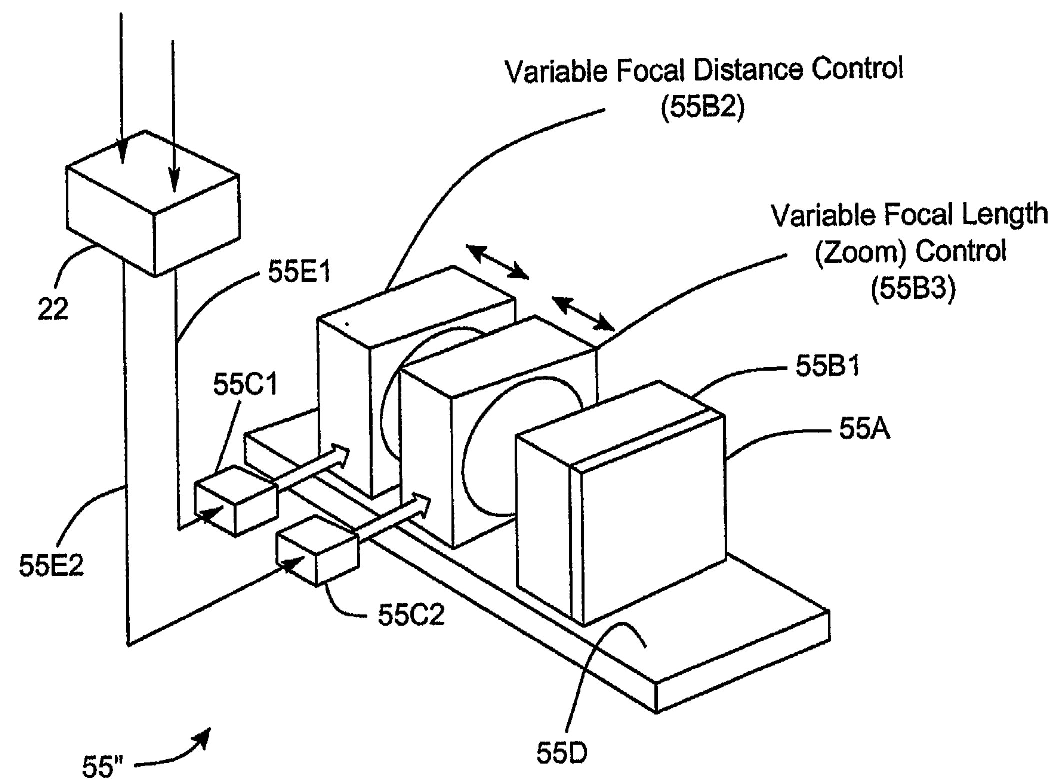

Variable Focal Distance Control
(55B2)
Variable Focal Length
(Zoom) Control
(55B3)
55B1
55A
55E1
22
55C1
55E2
55C2
55D
55"

FIG. 6B4

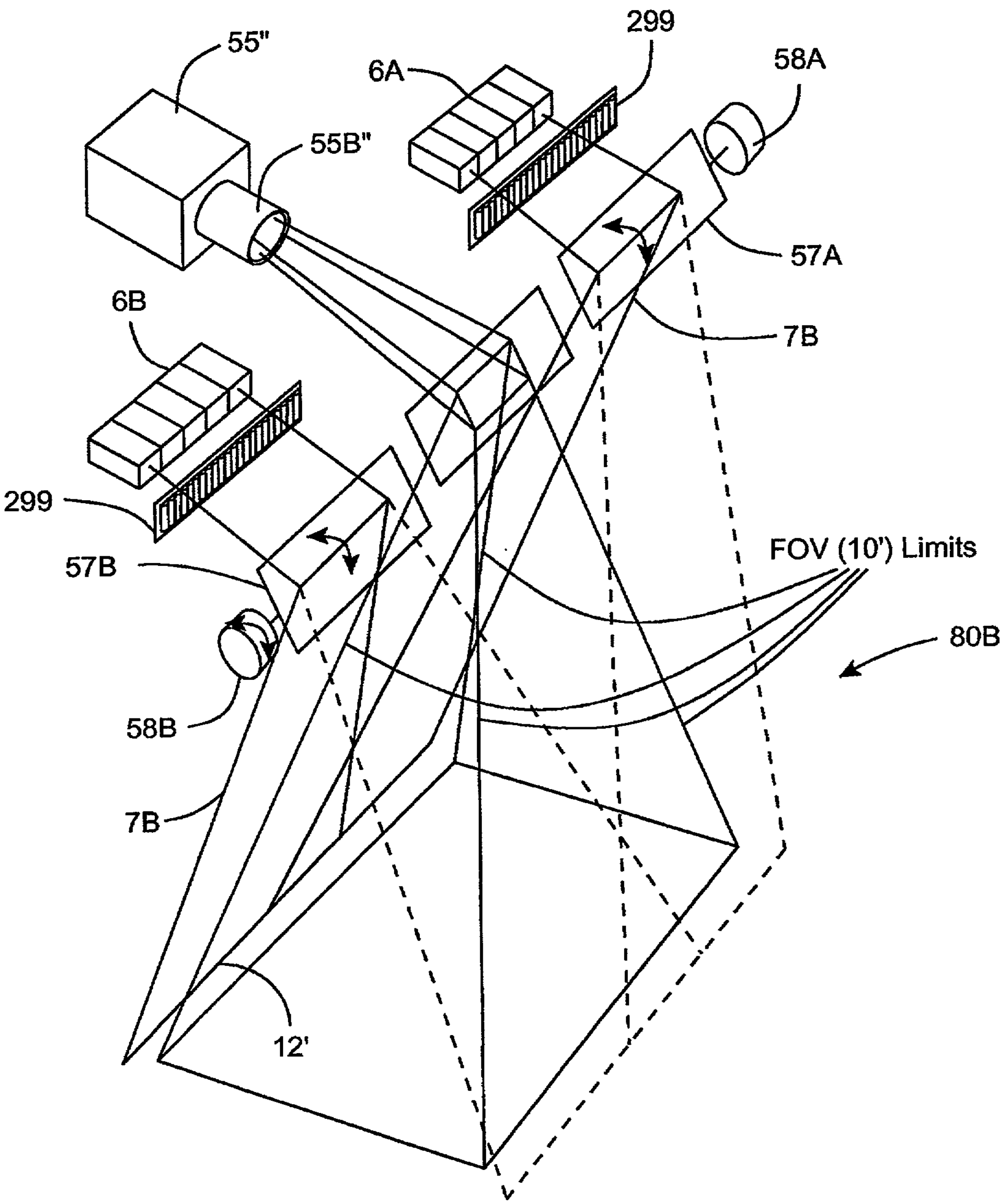


FIG. 6C1

(1) Variable Focal Length Camera Lens
(2) Variable Focal Distance

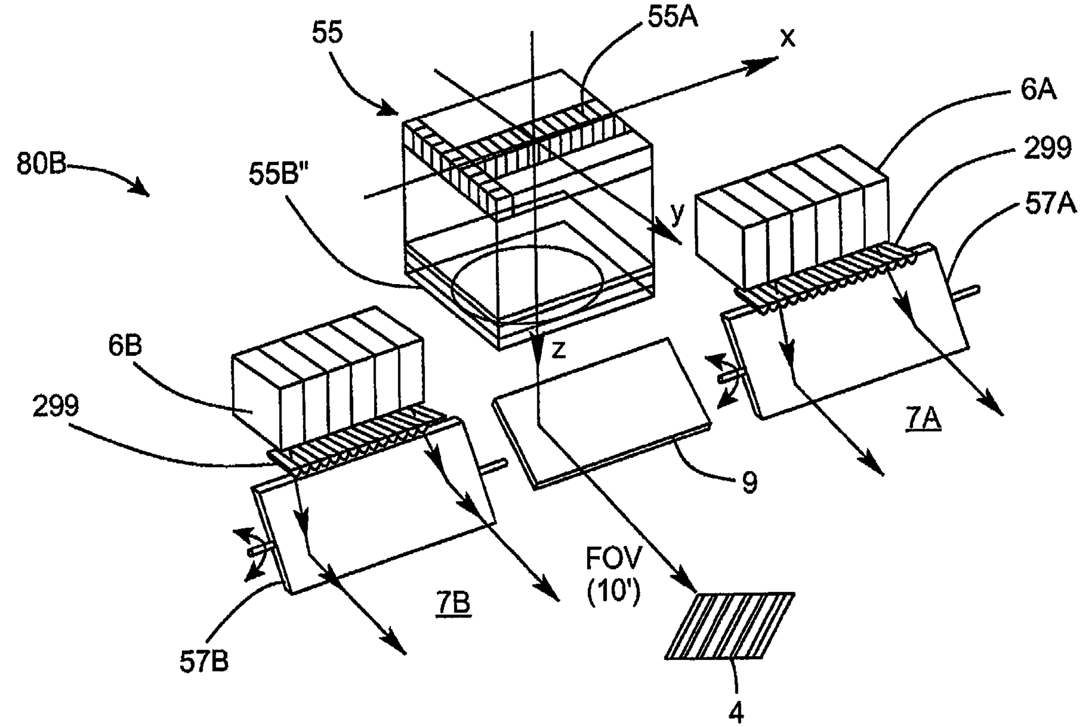
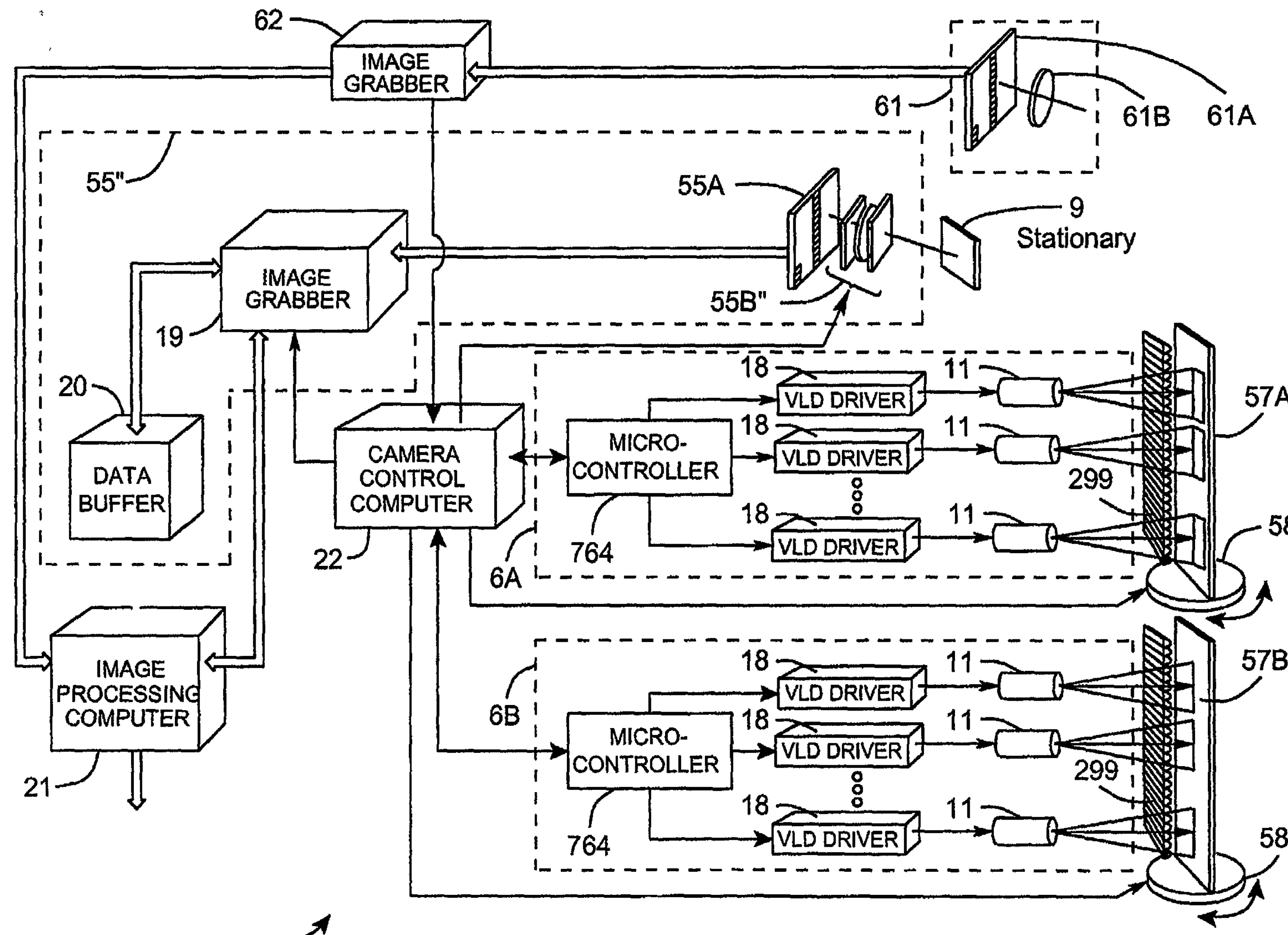
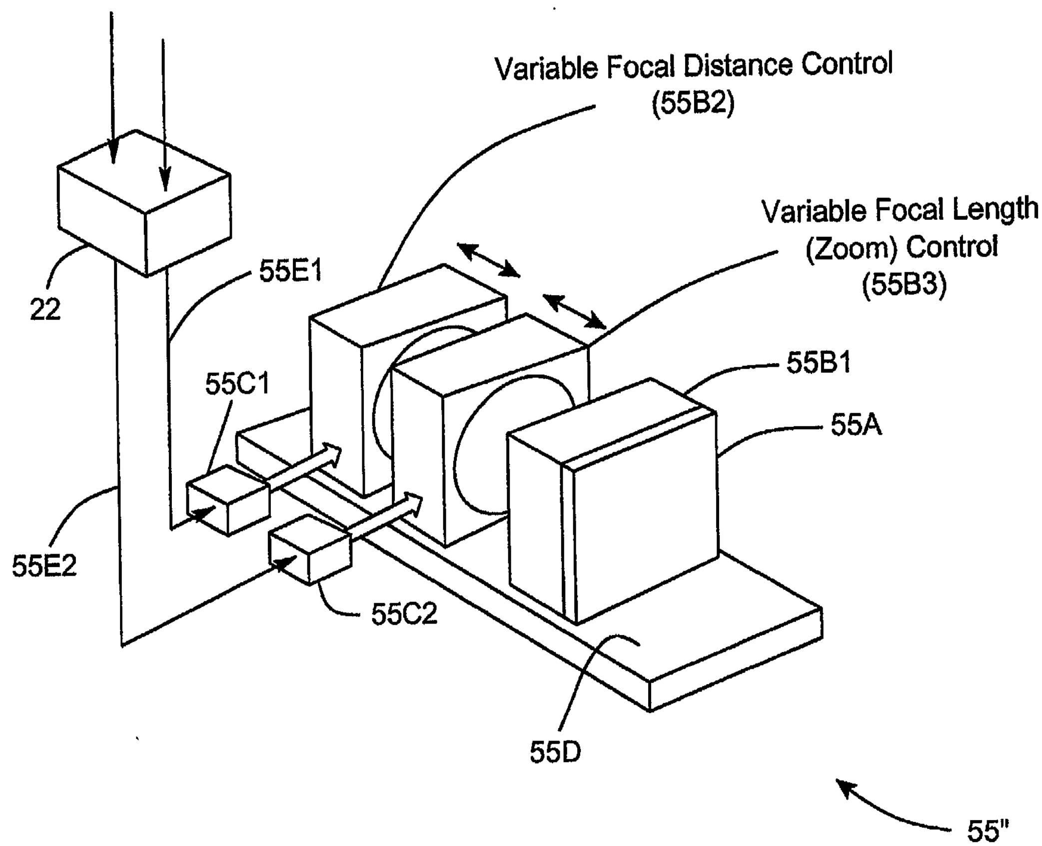


FIG. 6C2



62
IMAGE GRABBER
61
61B
61A
55"
55A
9
Stationary
IMAGE GRABBER
55B"
19
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
MICRO-CONTROLLER
764
6A
18
VLD DRIVER
11
299
57A
58A
6B
57B
58B
IMAGE PROCESSING COMPUTER
21
80B

FIG. 6C3



Variable Focal Distance Control
(55B2)
Variable Focal Length
(Zoom) Control
(55B3)
22
55E1
55C1
55B1
55A
55E2
55C2
55D
55"

FIG. 6C4

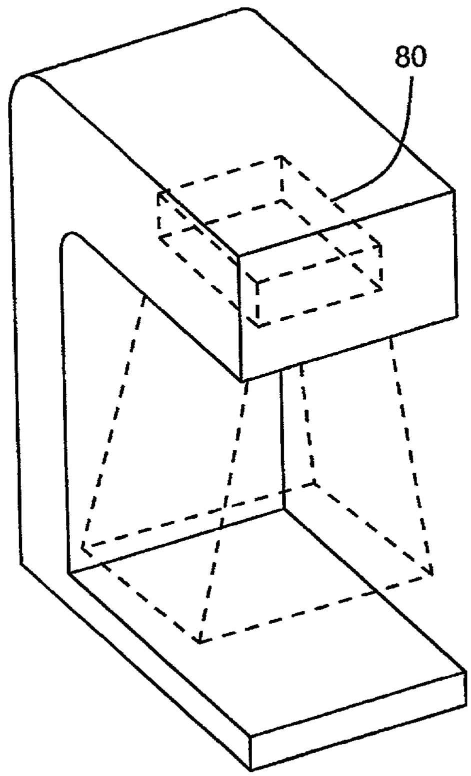


FIG. 6C5

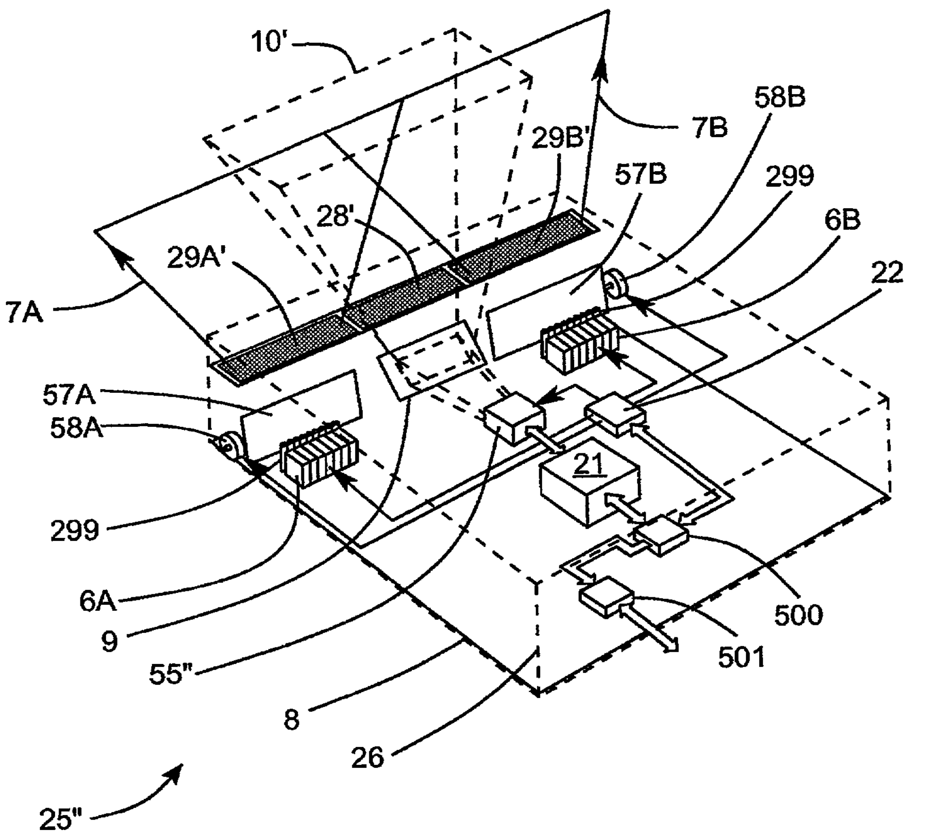
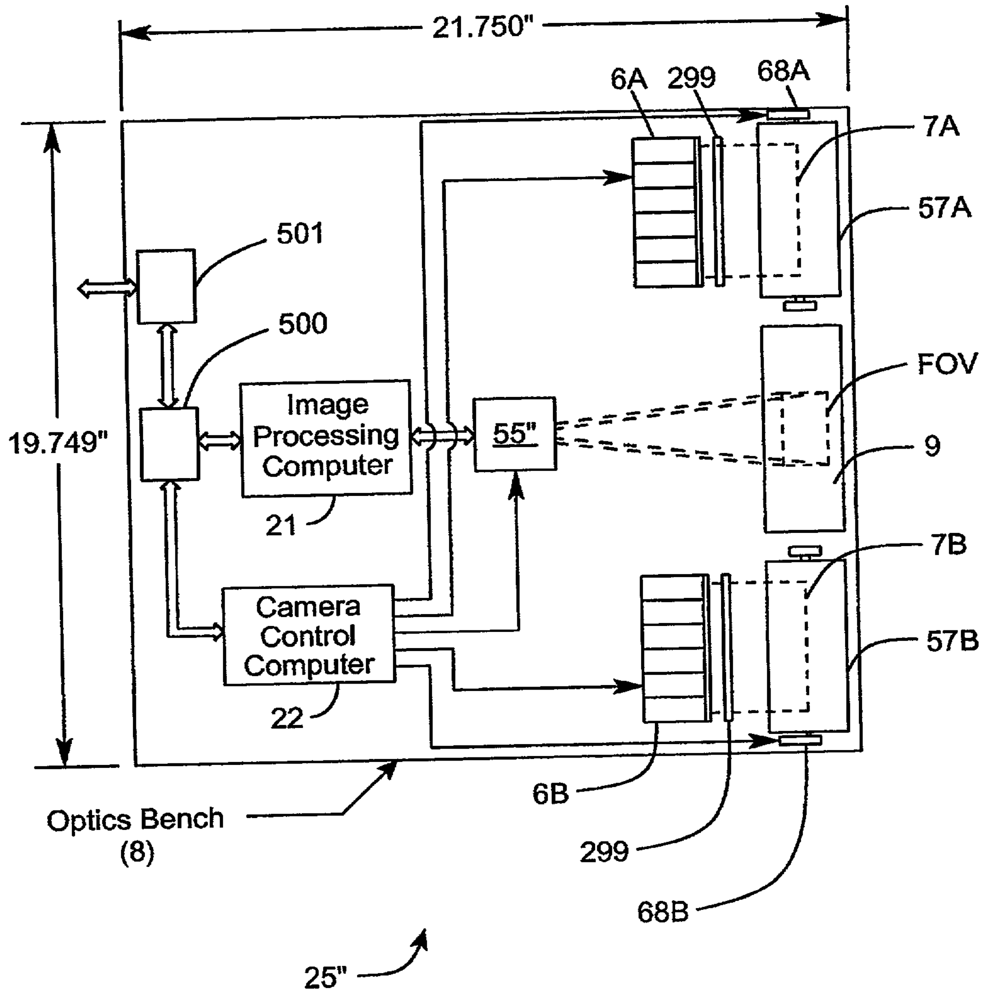

10'
7B
58B
29B'
57B
299
6B
28'
22
29A'
7A
57A
58A
21
299
6A
9
500
501
55"
8
26
25"

FIG. 6D1



21.750"
6A
299
68A
7A
57A
501
500
FOV
19.749"
Image
Processing
Computer
55"
9
21
7B
Camera
Control
Computer
57B
22
6B
Optics Bench
(8)
299
68B
25"

FIG. 6D2

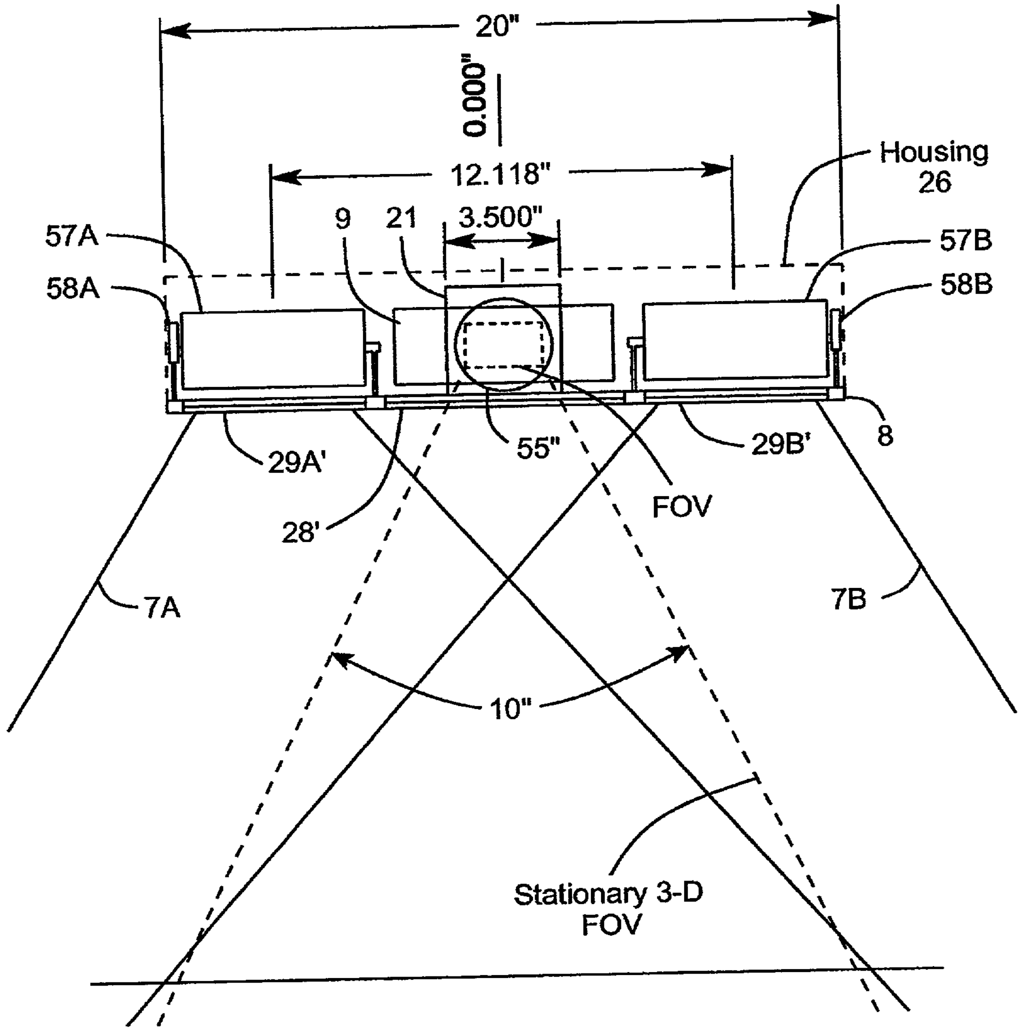

20"
0.000"
12.118"
Housing
26
9
21
3.500"
57A
58A
57B
58B
29A'
28'
55"
FOV
29B'
8
7A
7B
10"
Stationary 3-D
FOV

FIG. 6D3

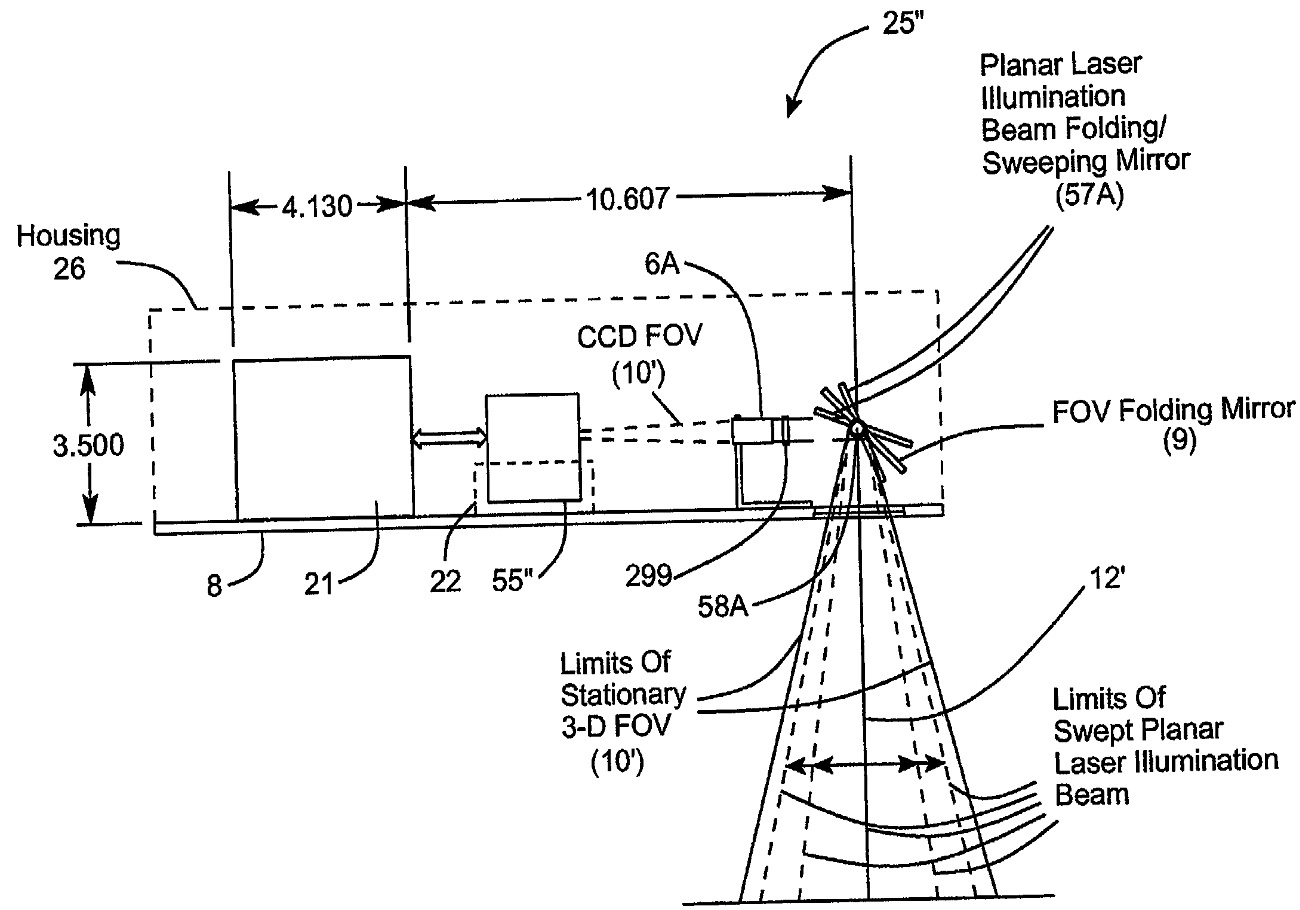

25"
Planar Laser
Illumination
Beam Folding/
Sweeping Mirror
(57A)
4.130
10.607
Housing
26
6A
CCD FOV
(10')
FOV Folding Mirror
(9)
3.500
8
21
22
55"
299
58A
12'
Limits Of
Stationary
3-D FOV
(10')
Limits Of
Swept Planar
Laser Illumination
Beam

FIG. 6D4

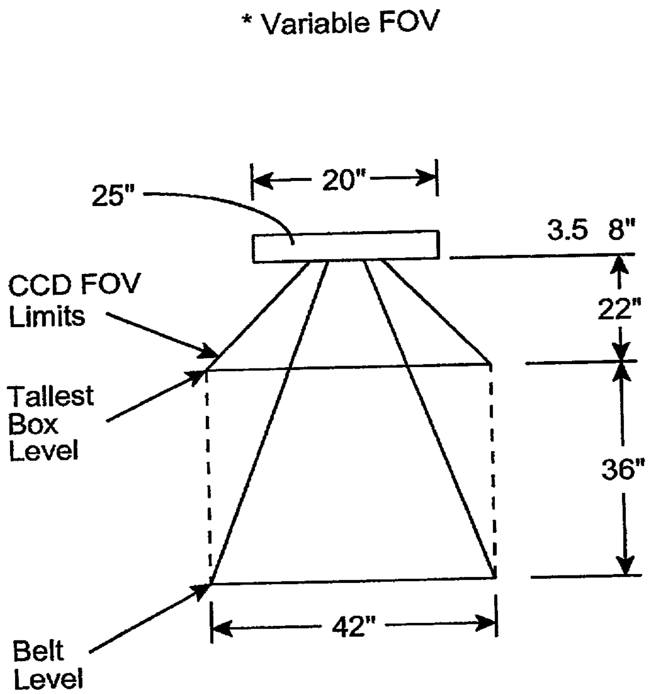

* Variable FOV
25"
20"
3.5 8"
CCD FOV
Limits
22"
Tallest
Box
Level
36"
42"
Belt
Level

FIG. 6D5

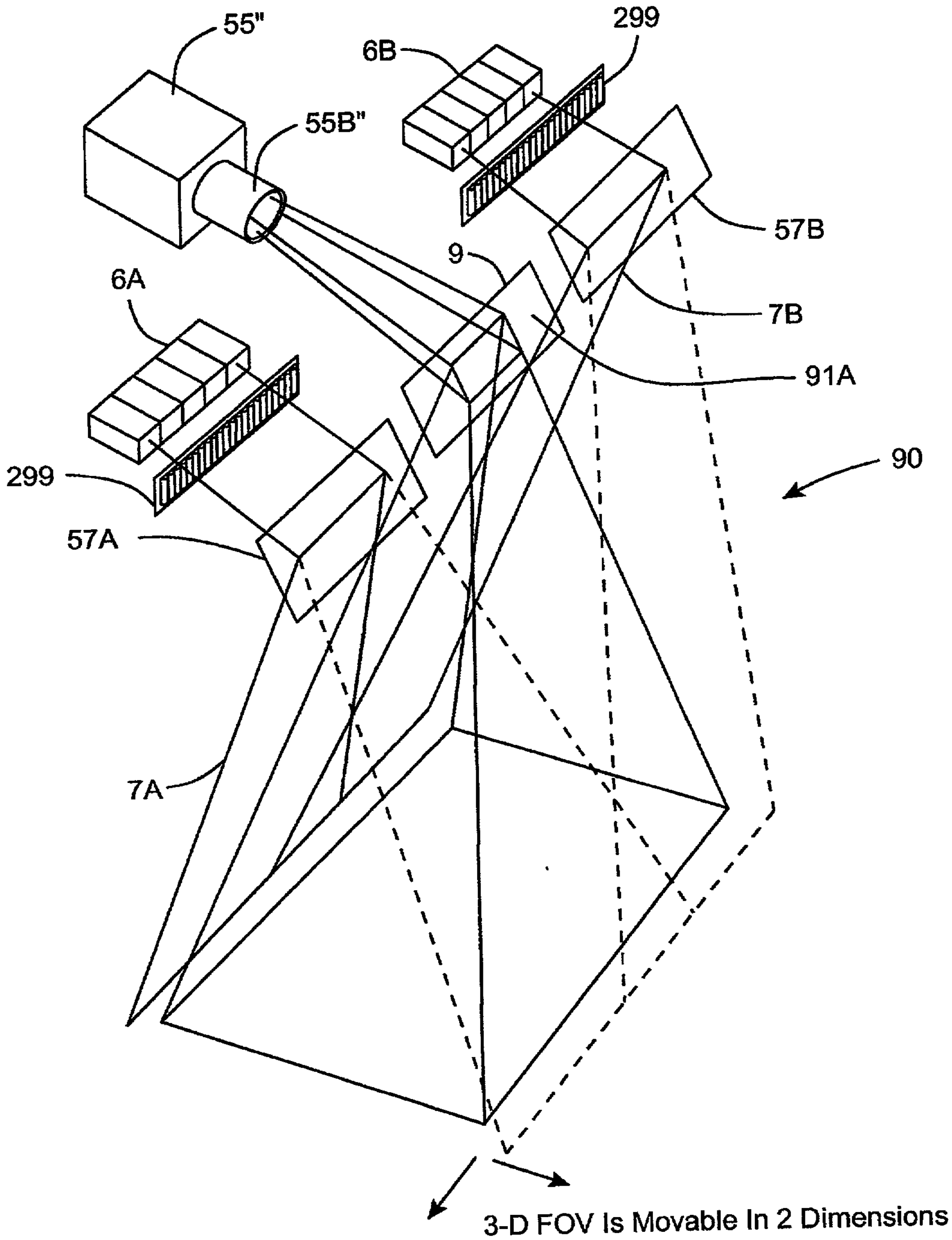

55"
299
6B
55B"
57B
9
6A
7B
91A
90
299
57A
7A
3-D FOV Is Movable In 2 Dimensions

FIG. 6E1

(1) Variable Focal Length Camera Lens
(2) Variable Focal Distance

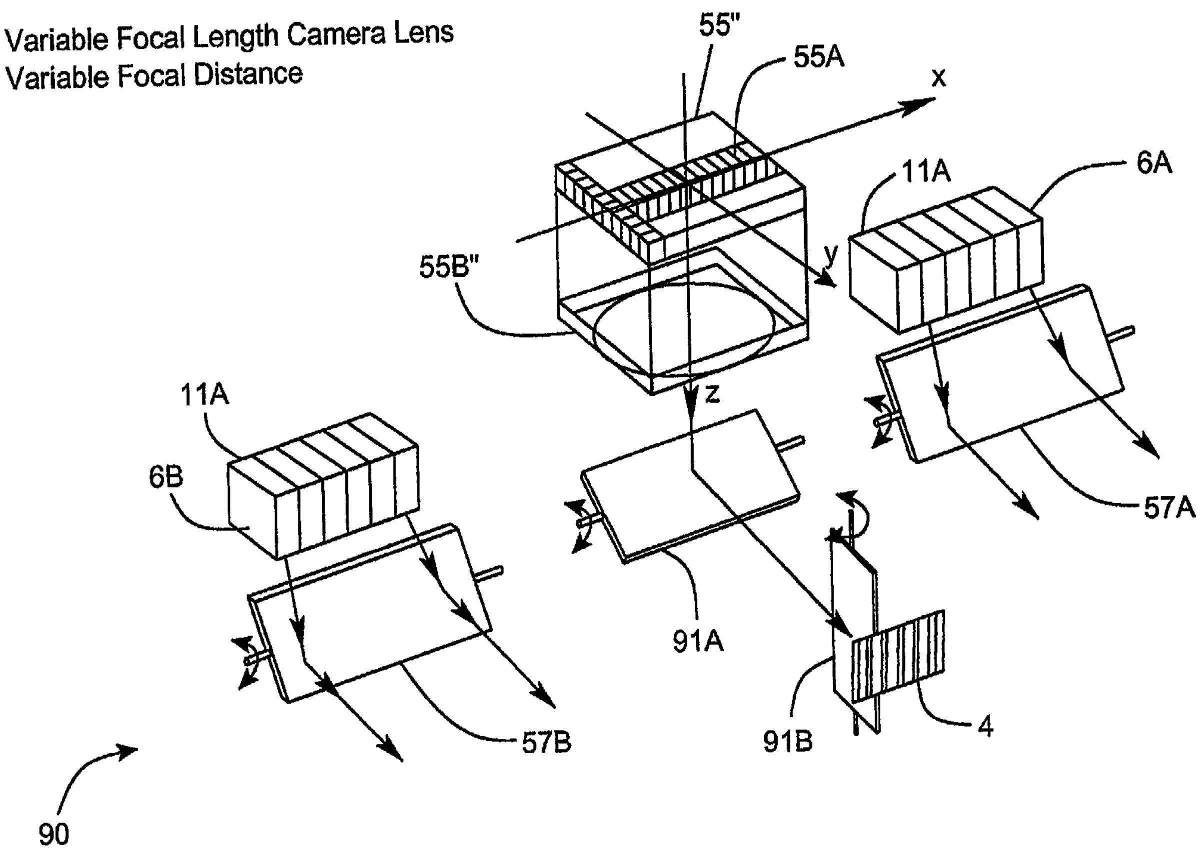


FIG. 6E2

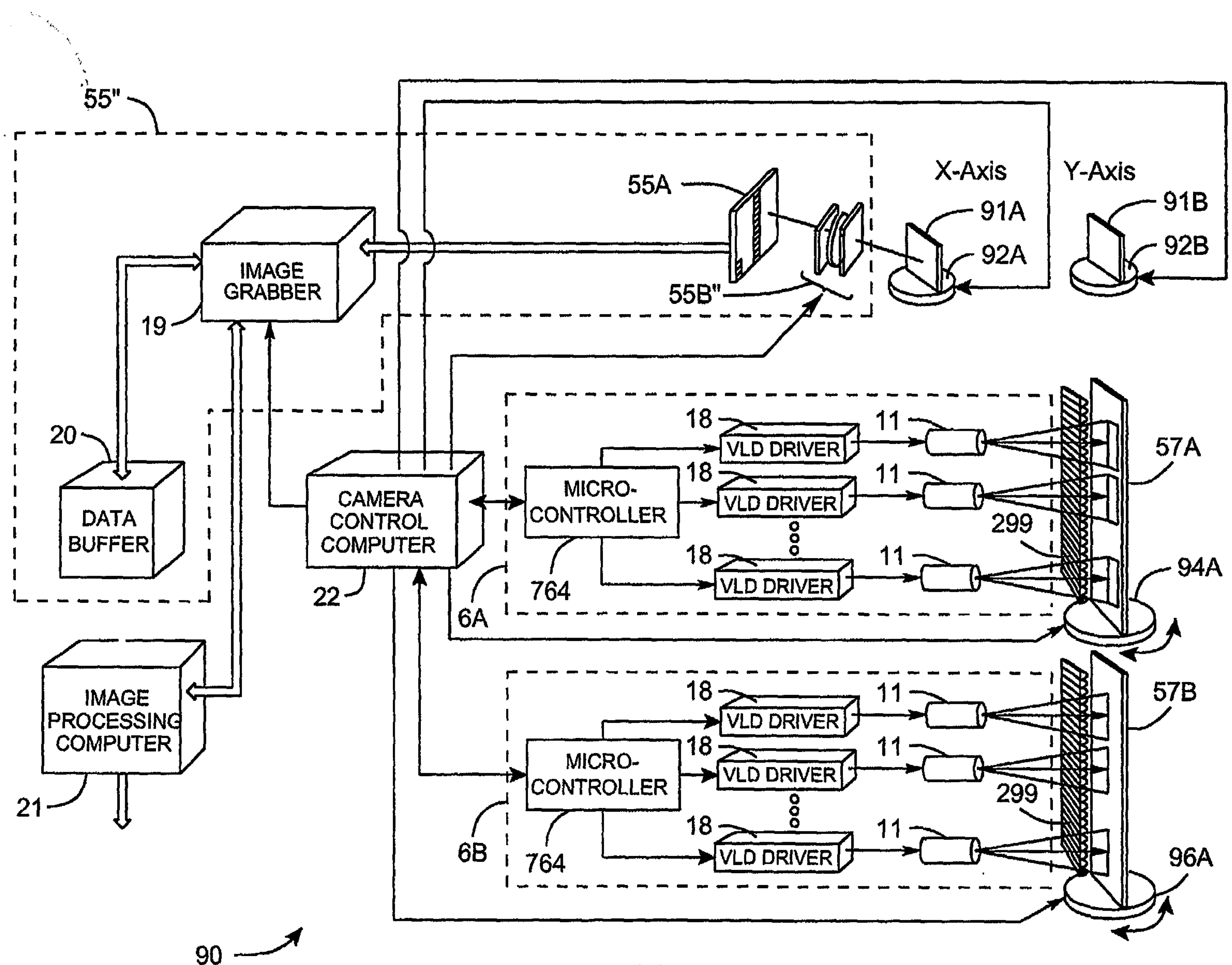

55"
55A
X-Axis
Y-Axis
91A
92A
91B
92B
IMAGE GRABBER
19
55B"
20
DATA BUFFER
CAMERA CONTROL COMPUTER
22
18
VLD DRIVER
11
MICRO-CONTROLLER
764
6A
57A
299
94A
6B
57B
96A
IMAGE PROCESSING COMPUTER
21
90

FIG. 6E3

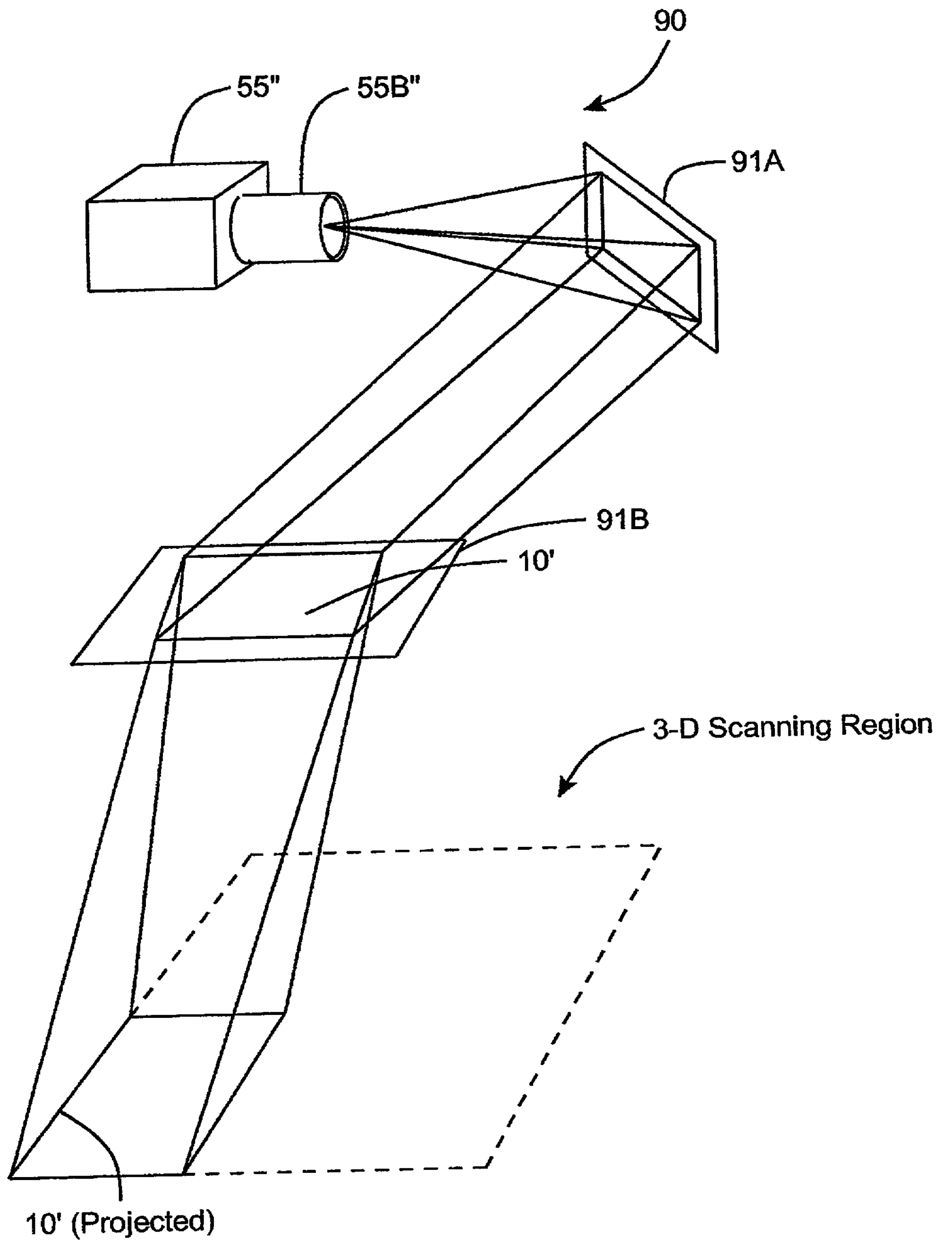
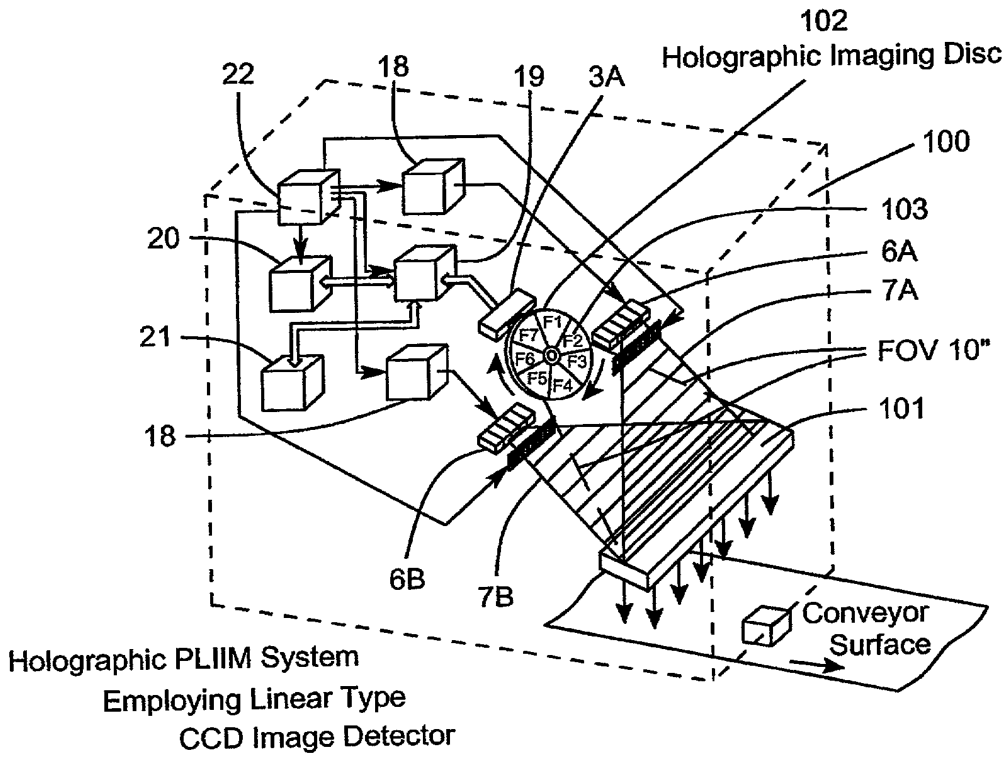
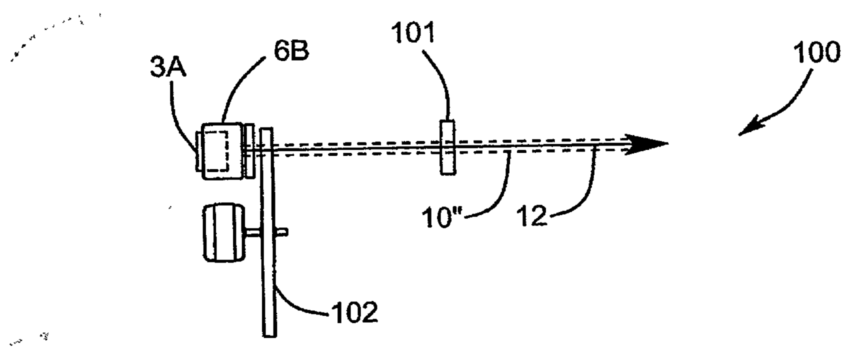


FIG. 6E4



102
Holographic Imaging Disc
22
18
19
3A
100
103
20
6A
7A
21
FOV 10"
F1
F2
F3
F4
F5
F6
F7
101
18
6B
7B
Conveyor
Surface
Holographic PLIIM System
Employing Linear Type
CCD Image Detector

FIG. 7A



3A
6B
101
100
10"
12
102

FIG. 7B

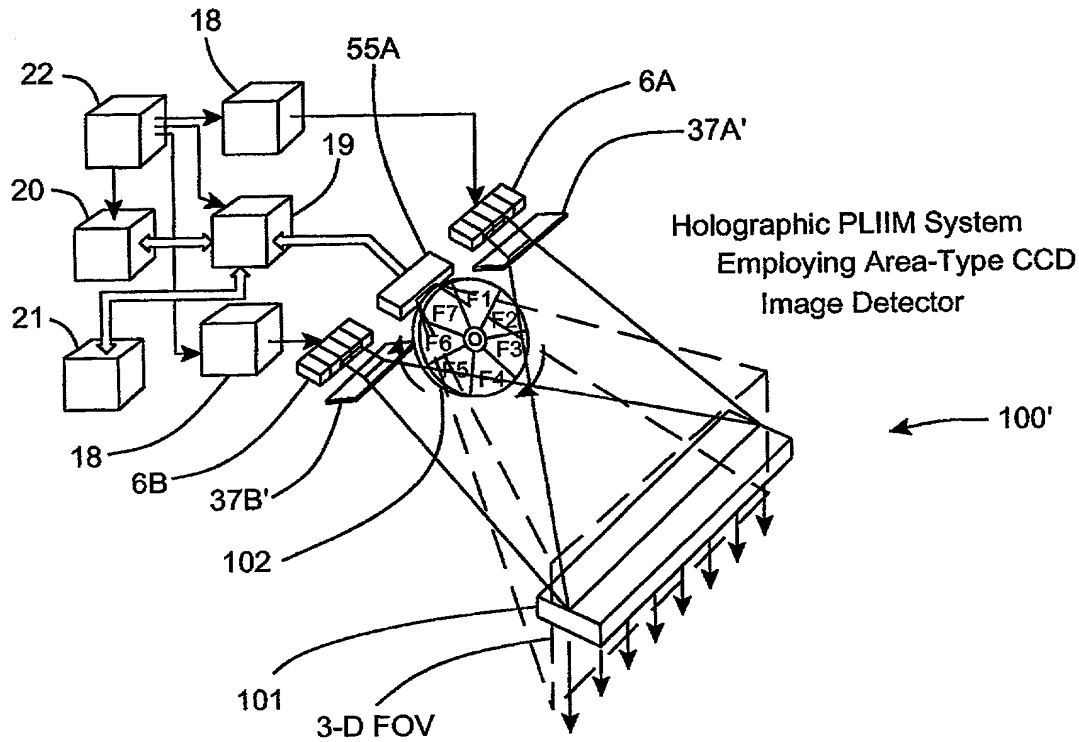

18
55A
22
6A
37A'
19
20
Holographic PLIIM System
Employing Area-Type CCD
Image Detector
F1
F7
F2
F6
F3
F5
F4
21
100'
18
6B
37B'
102
101
3-D FOV

FIG. 8A

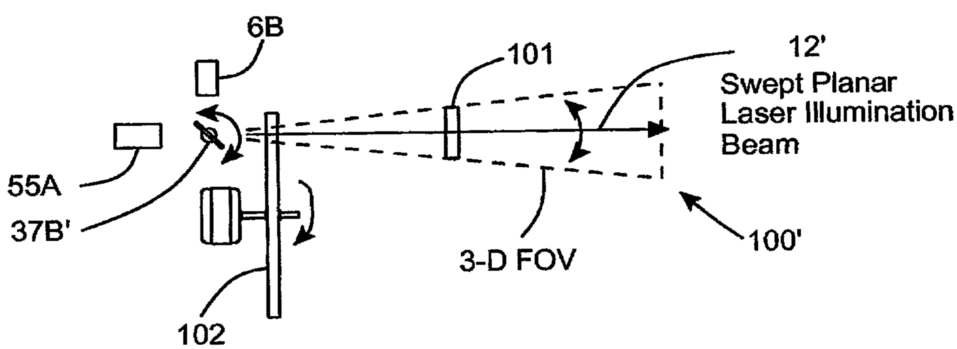

6B
101
12'
Swept Planar
Laser Illumination
Beam
55A
37B'
3-D FOV
100'
102

FIG. 8B

1-D Scanner Embodiment

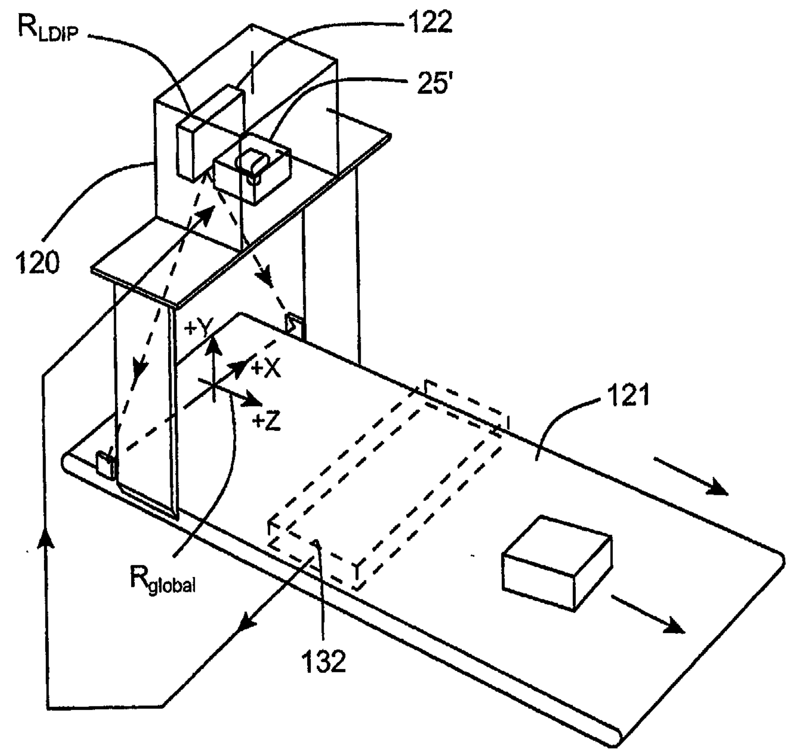


FIG. 9

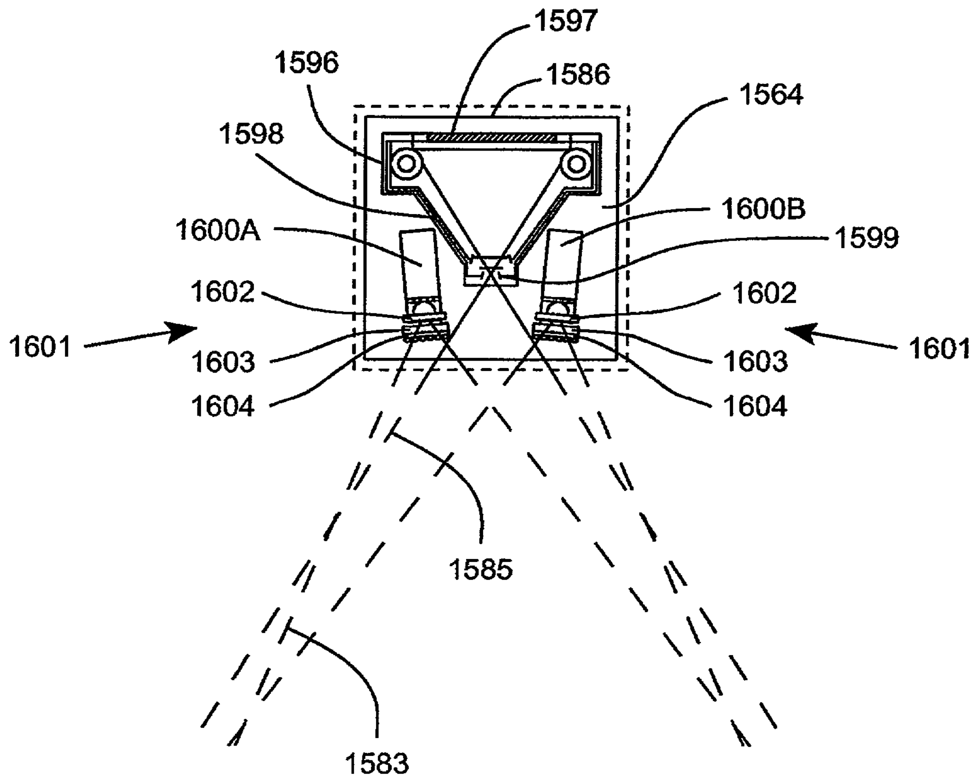


FIG. 43C

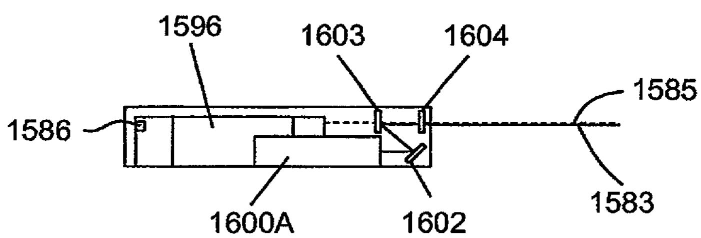


FIG. 43D

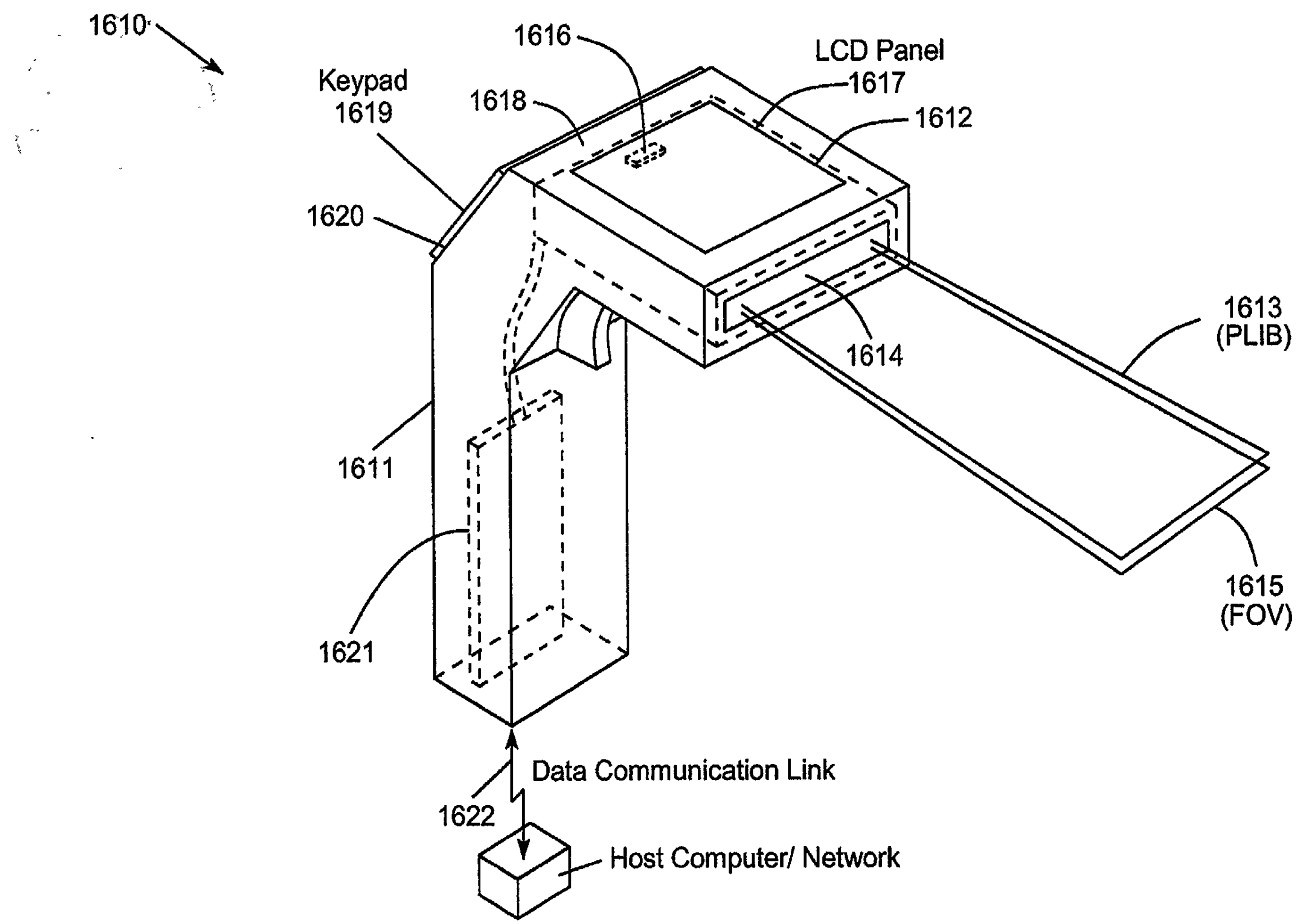

1610
Keypad
1619
1620
1616
1618
LCD Panel
1617
1612
1614
1613
(PLIB)
1611
1621
1615
(FOV)
Data Communication Link
1622
Host Computer/ Network

FIG. 44A

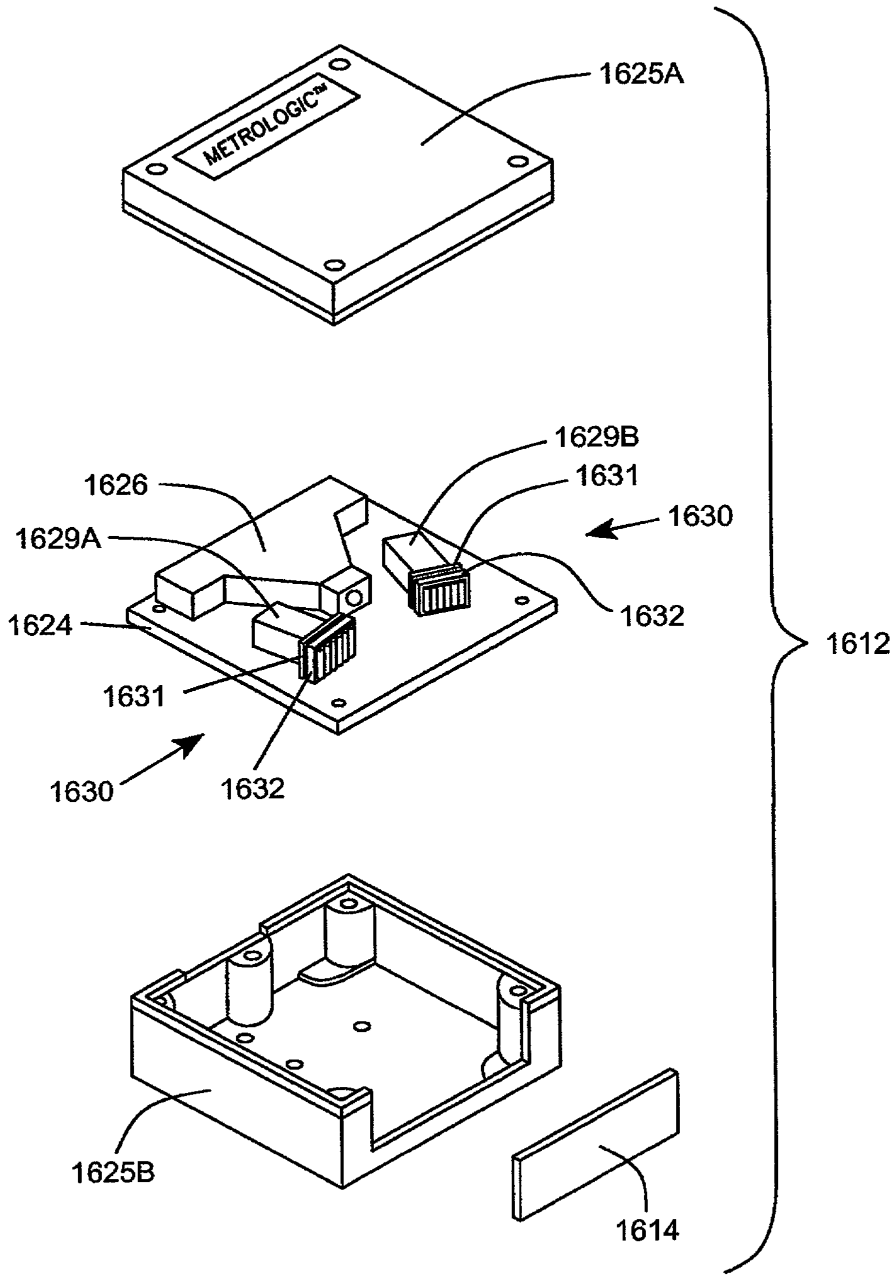

1625A
METROLOGIC™
1629B
1626
1631
1630
1629A
1632
1624
1612
1631
1630
1632
1625B
1614

FIG. 44B

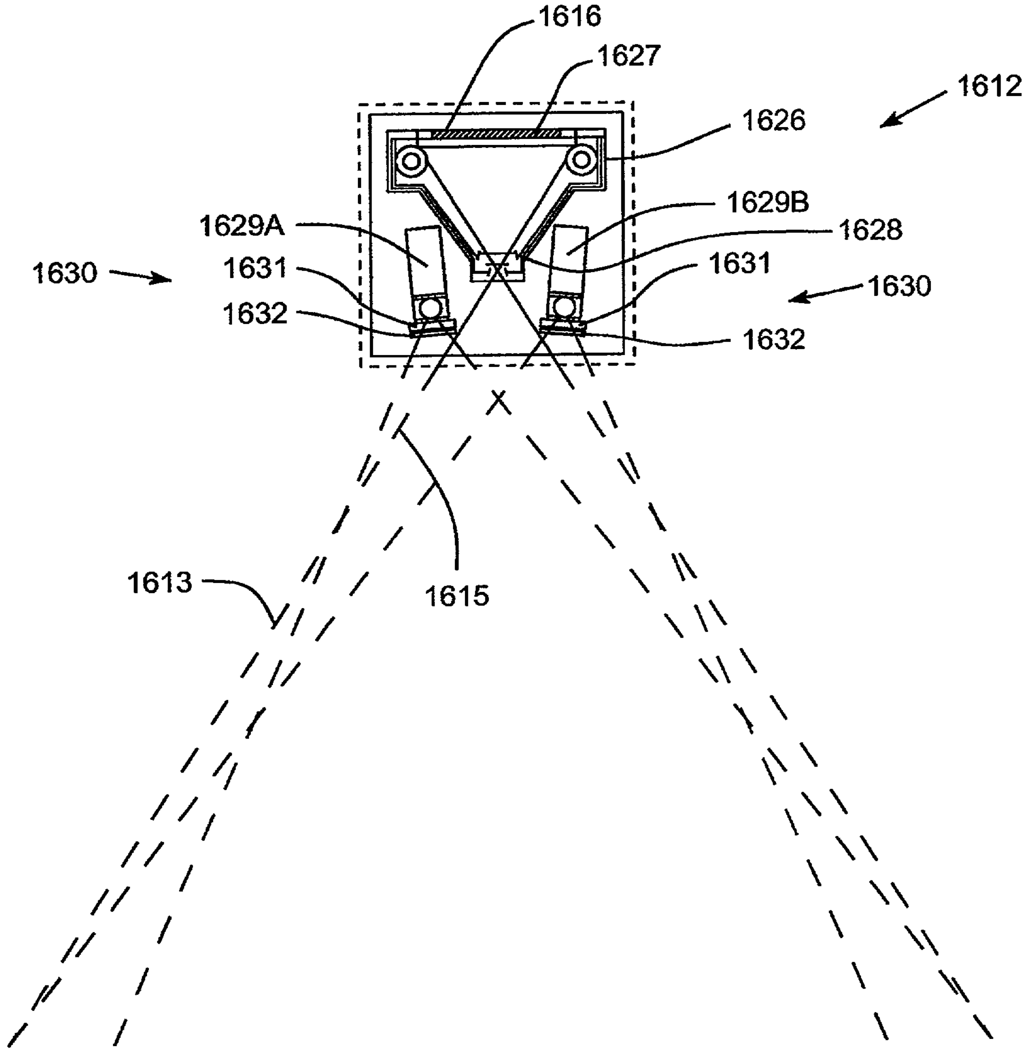

1616
1627
1612
1626
1629B
1629A
1628
1630
1631
1631
1630
1632
1632
1613
1615

FIG. 44C

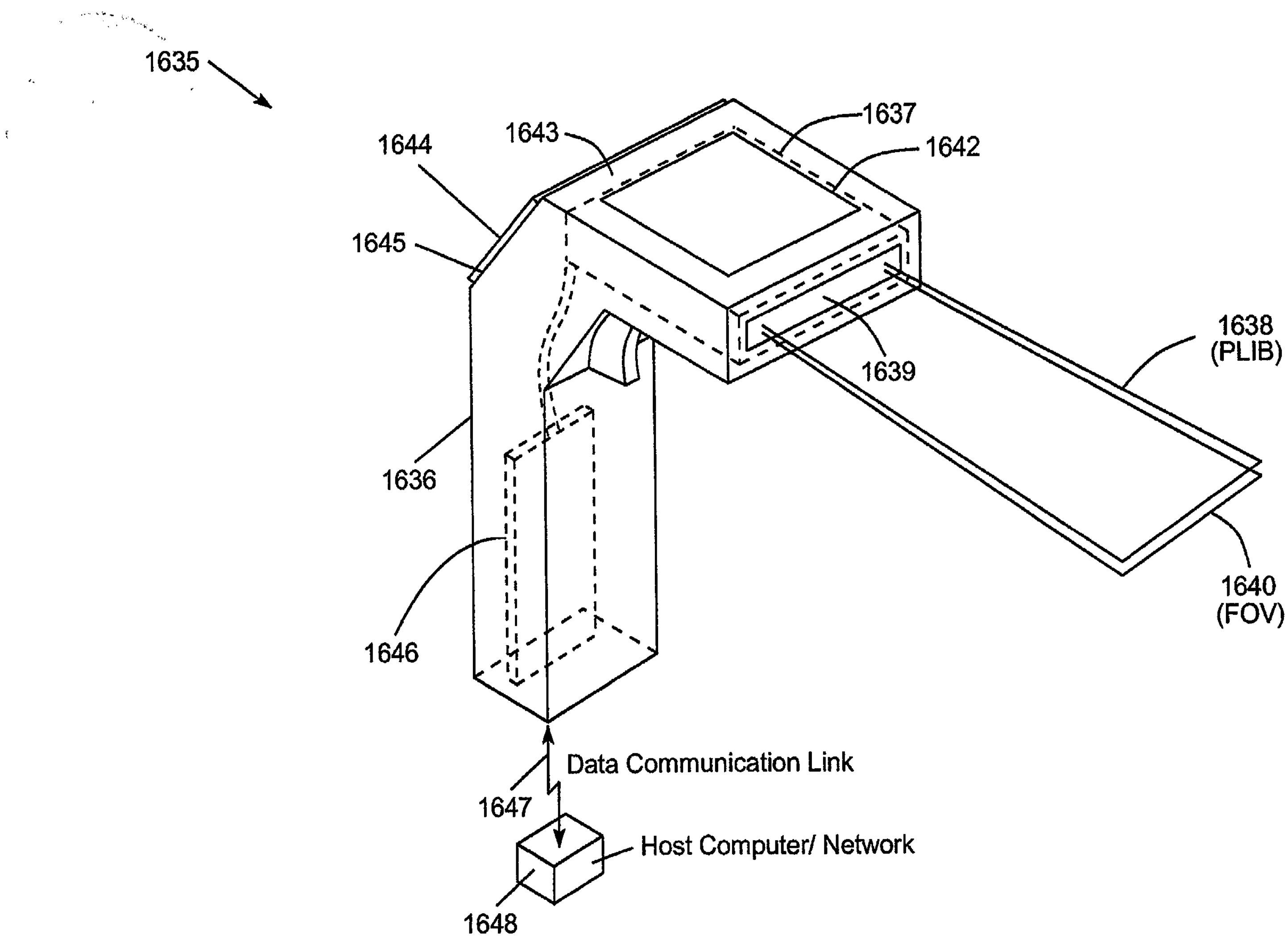
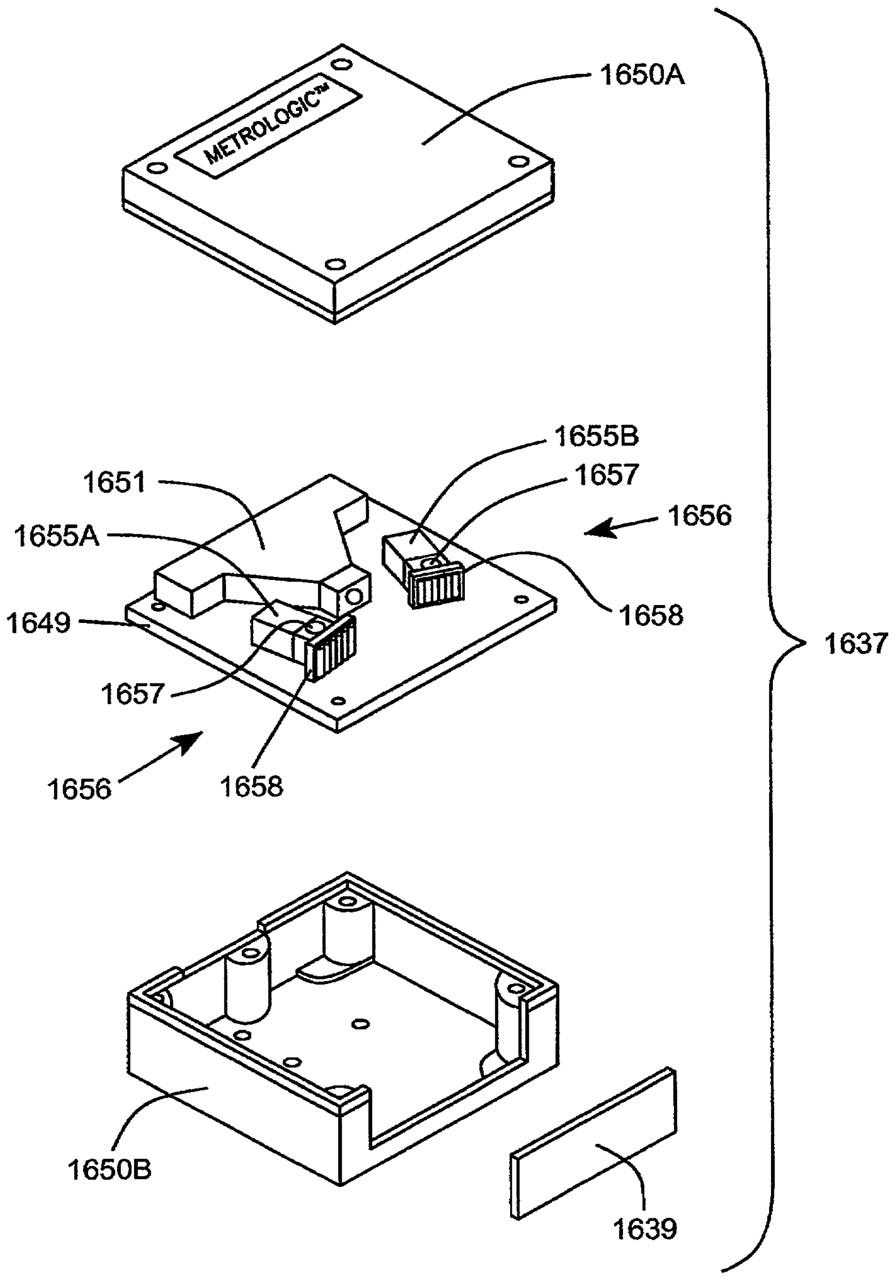

1635
1644
1643
1637
1642
1645
1639
1638
(PLIB)
1636
1640
(FOV)
1646
Data Communication Link
1647
Host Computer/ Network
1648

FIG. 45A



1650A
METROLOGIC™
1655B
1651
1657
1656
1655A
1649
1658
1637
1657
1656
1658
1650B
1639

FIG. 45B

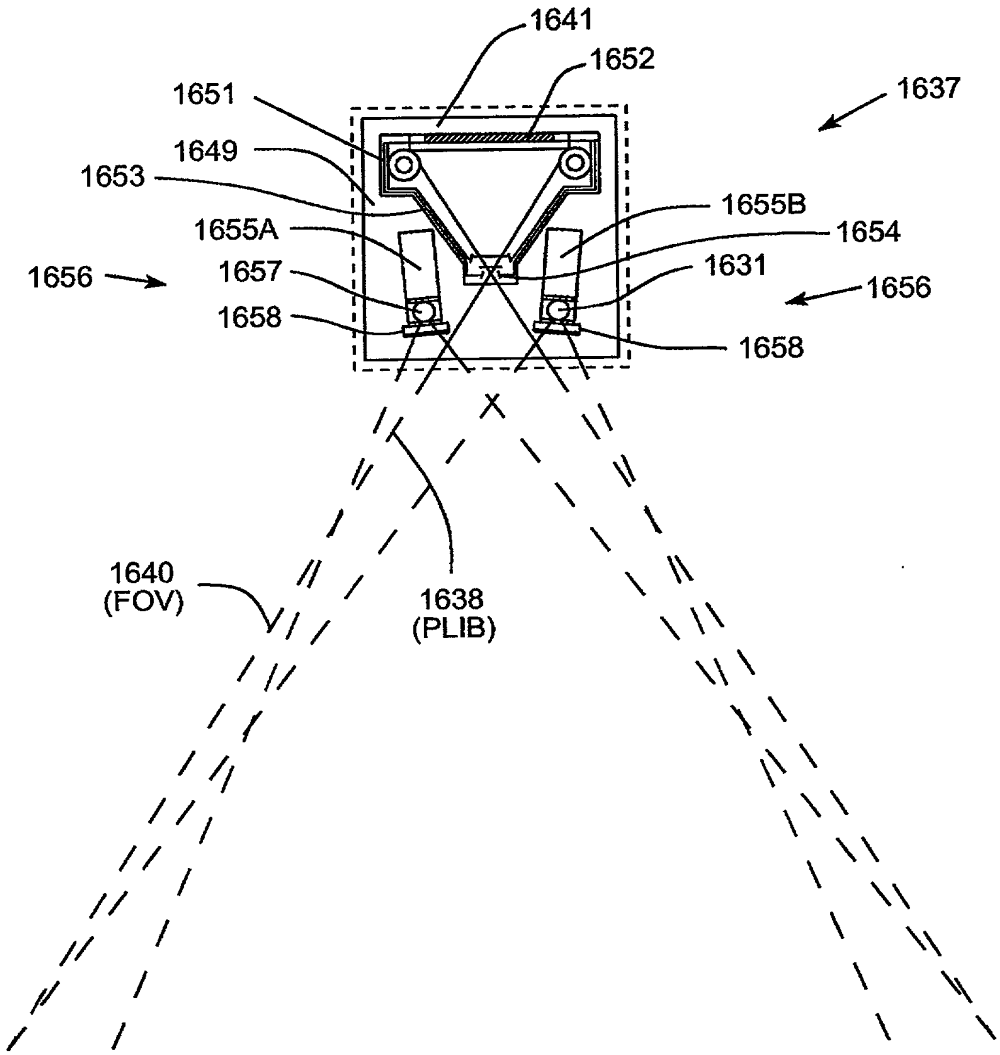

1641
1652
1651
1637
1649
1653
1655B
1655A
1654
1657
1631
1656
1656
1658
1658
1640
(FOV)
1638
(PLIB)

FIG. 45C

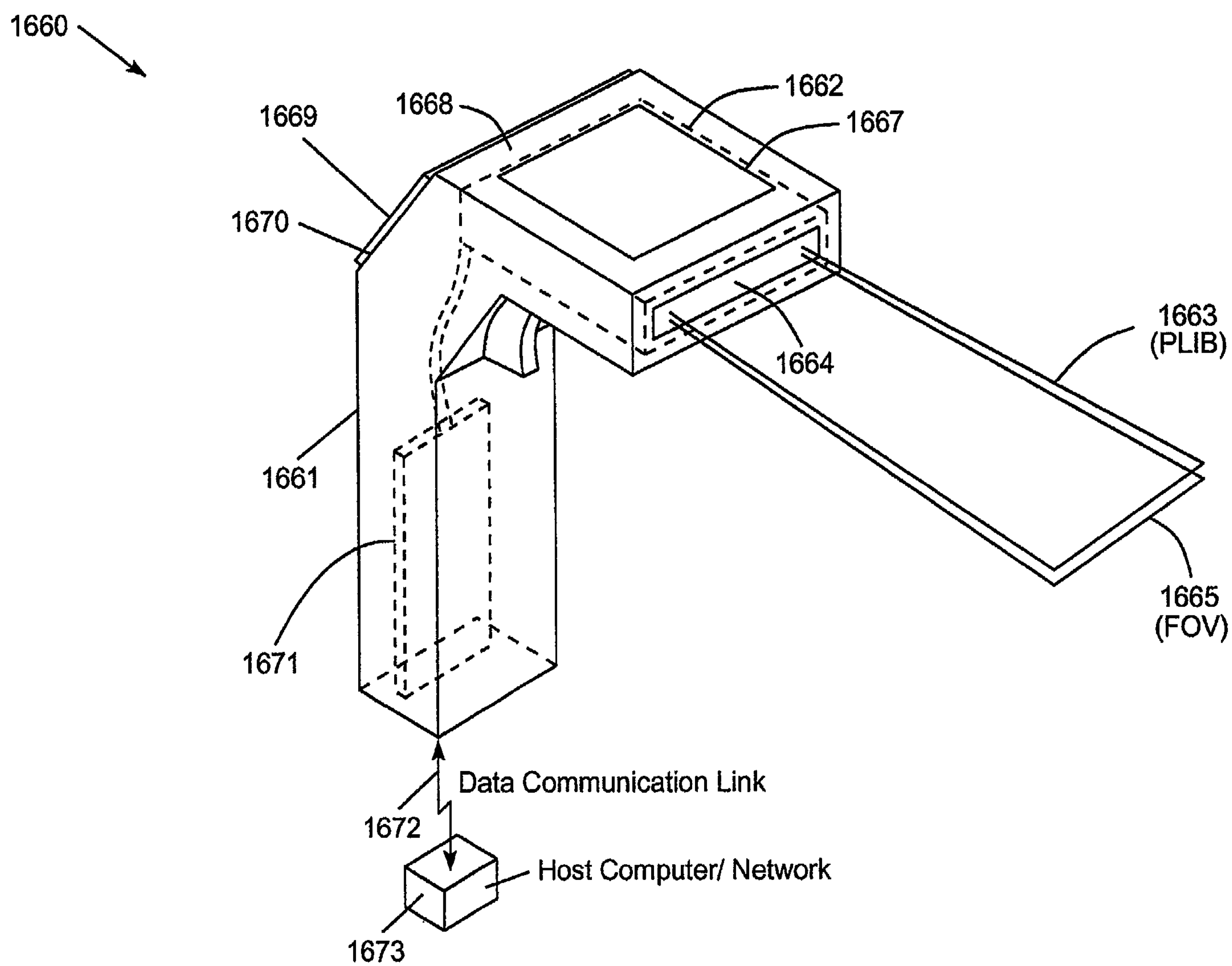

1660
1669
1668
1662
1667
1670
1664
1663
(PLIB)
1661
1671
1665
(FOV)
Data Communication Link
1672
Host Computer/ Network
1673

FIG. 46A

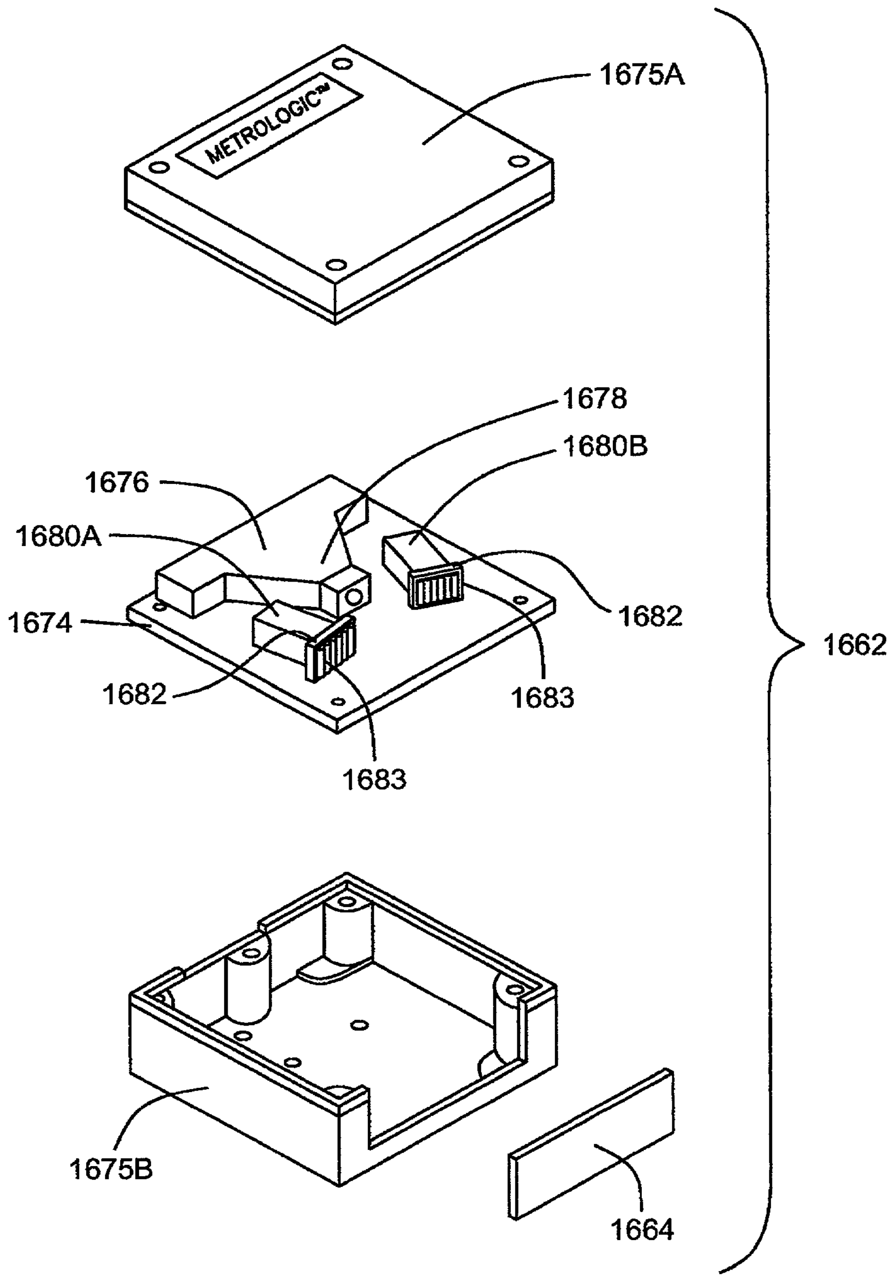

1675A
METROLOGIC™
1678
1680B
1676
1680A
1674
1682
1682
1683
1683
1662
1675B
1664

FIG. 46B

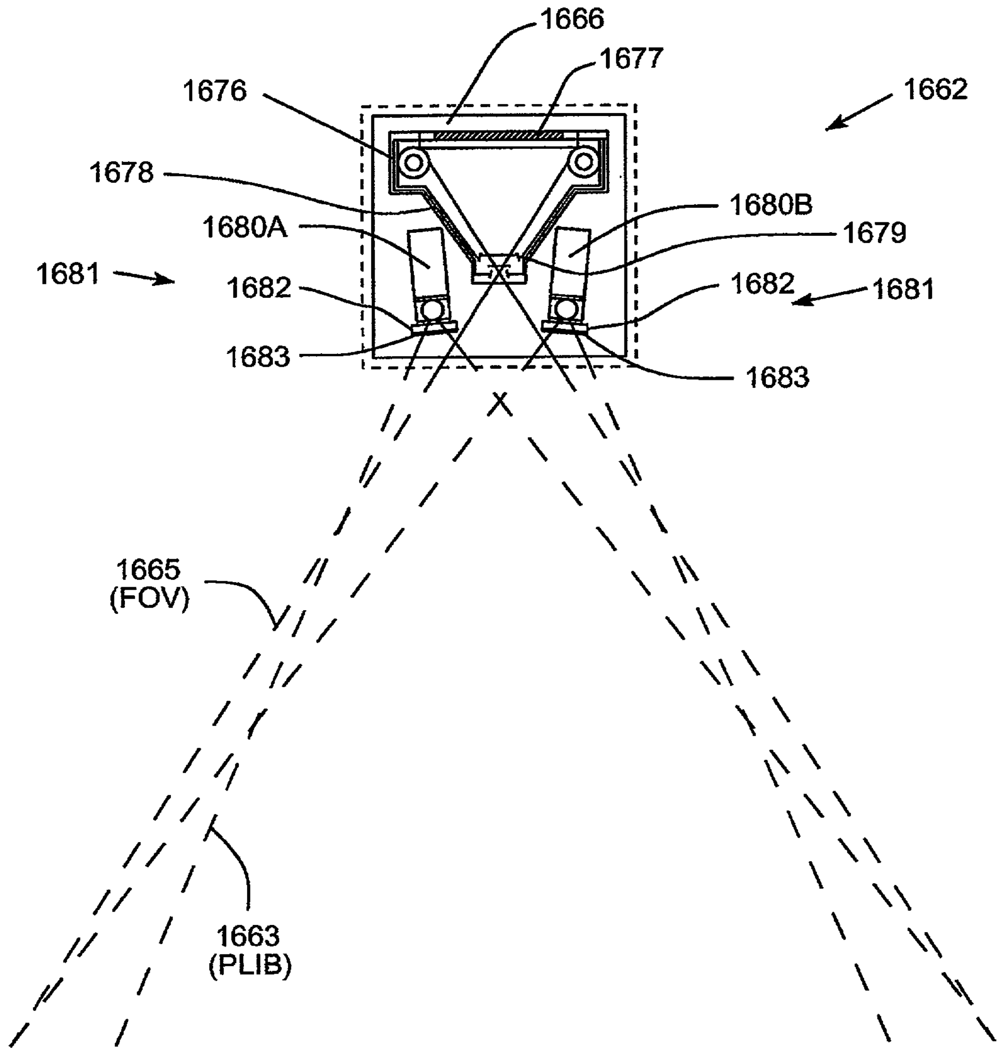

1666
1677
1676
1662
1678
1680B
1680A
1679
1681
1682
1682
1681
1683
1683
1665
(FOV)
1663
(PLIB)

FIG. 46C

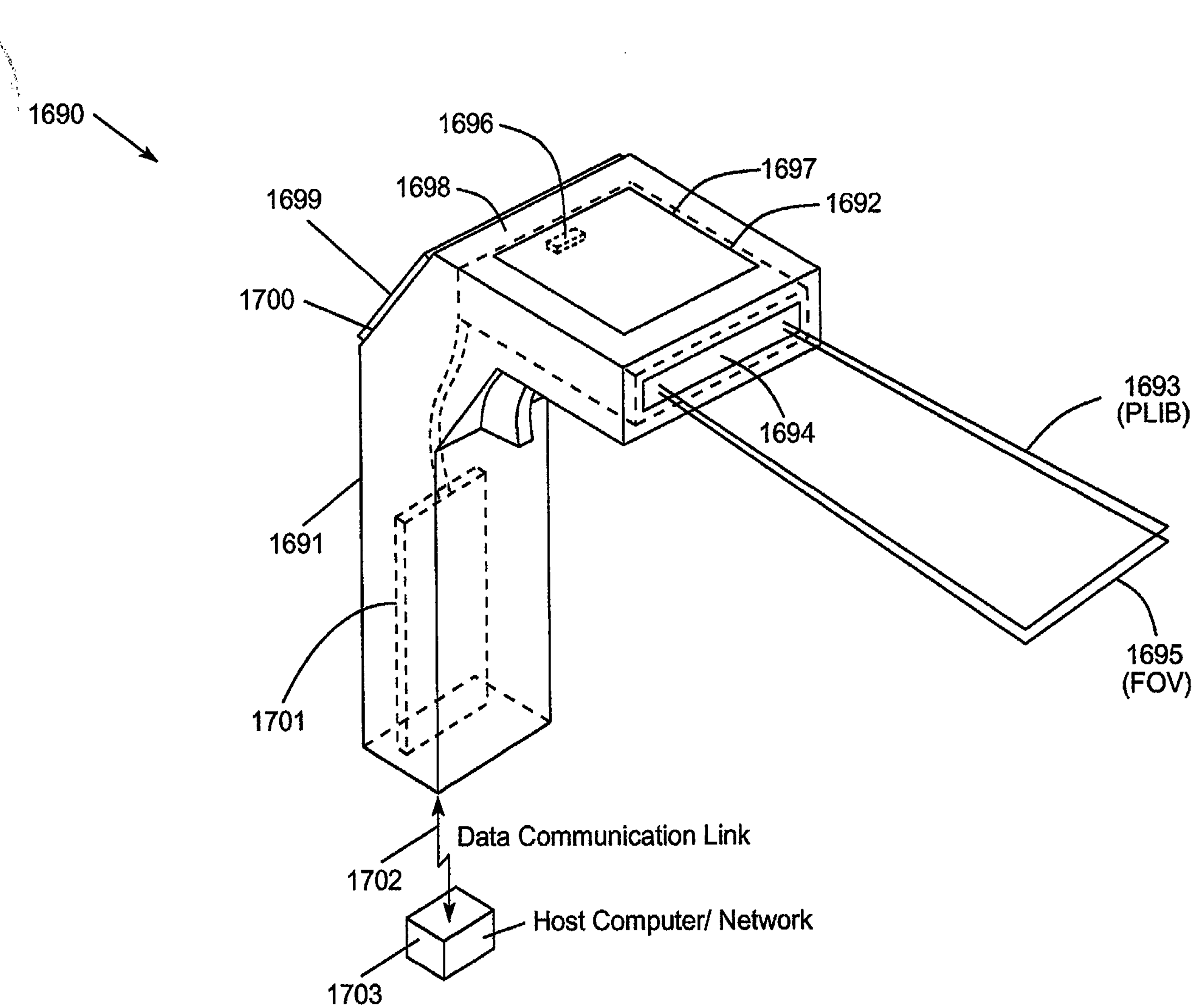

1690
1696
1697
1692
1698
1699
1700
1691
1701
1694
1693
(PLIB)
1695
(FOV)
Data Communication Link
1702
Host Computer/ Network
1703

FIG. 47A

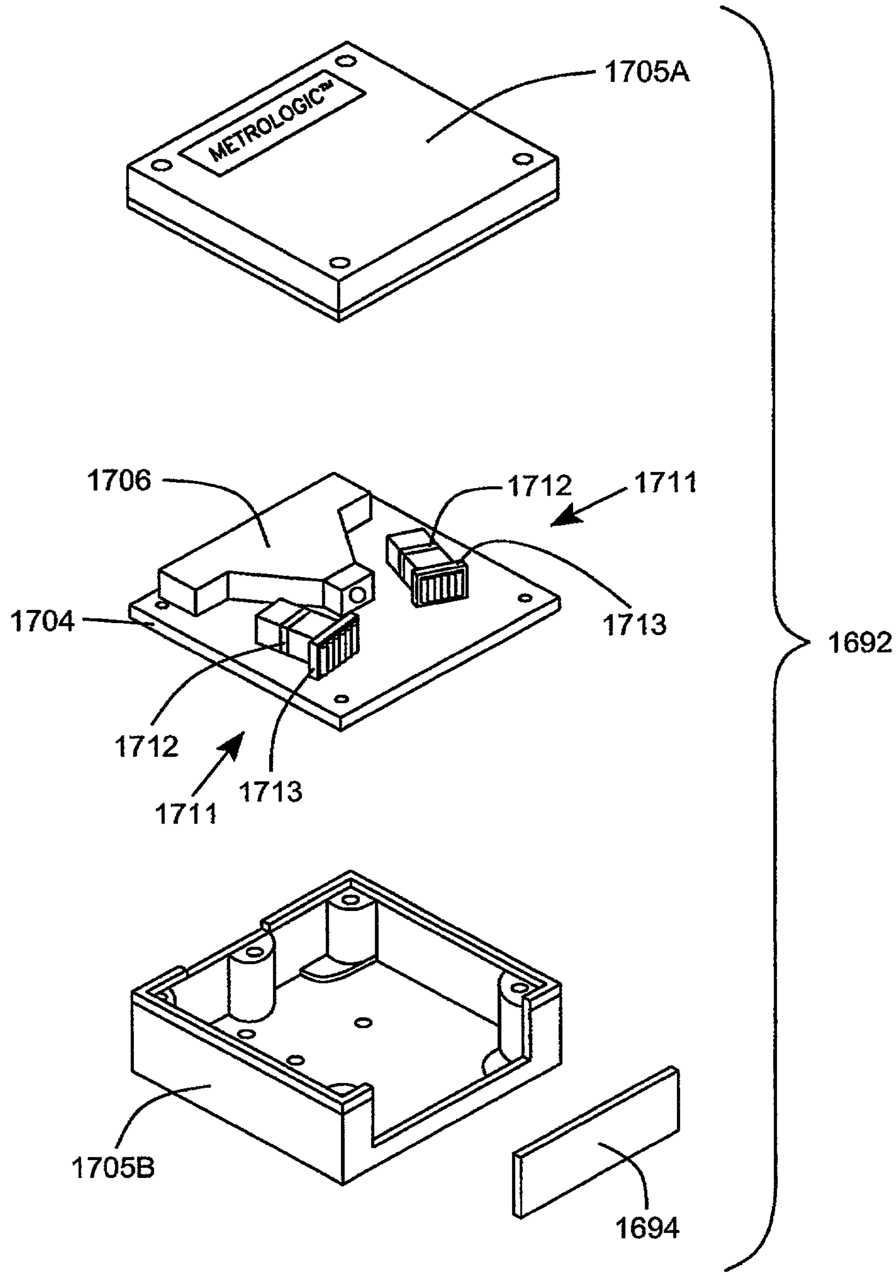

1705A
METROLOGIC™
1706
1712
1711
1704
1713
1692
1712
1711
1713
1705B
1694

FIG. 47B

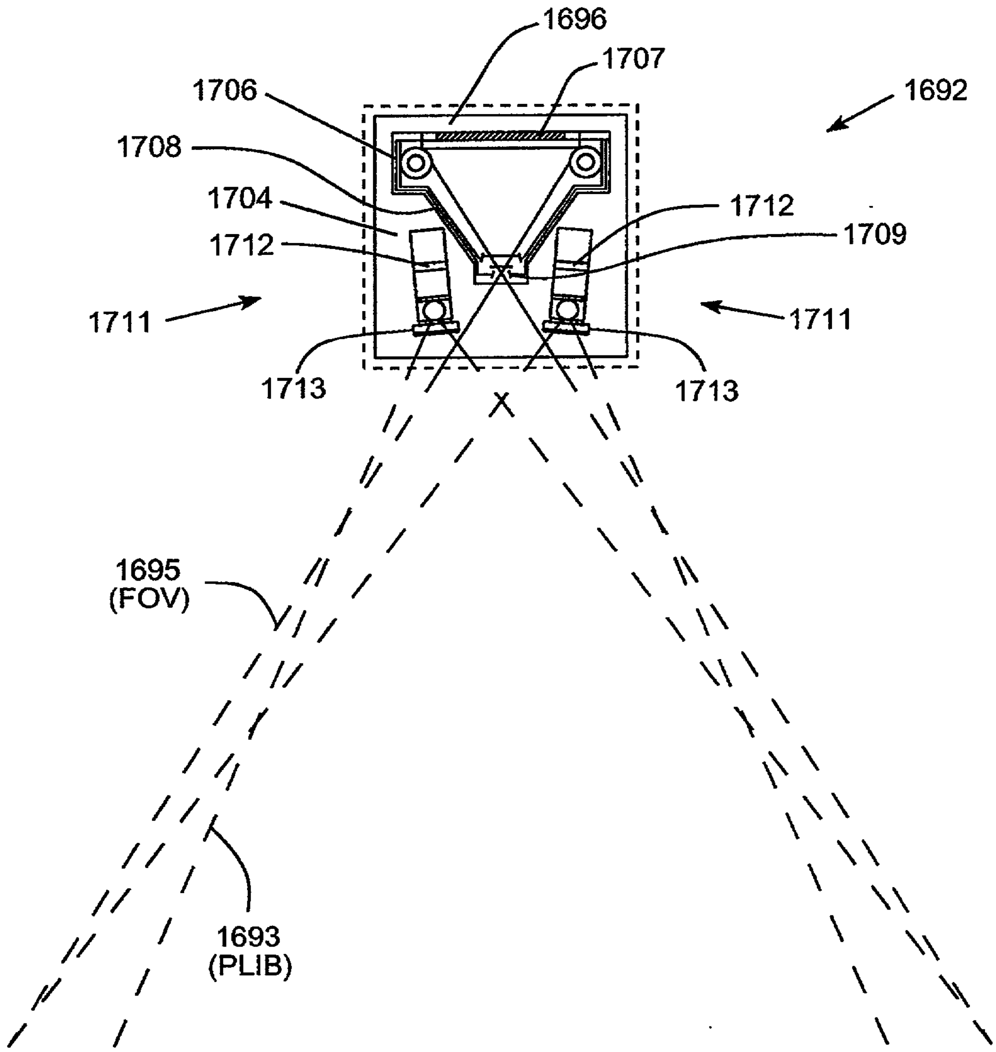

1696
1707
1706
1692
1708
1712
1704
1709
1712
1711
1711
1713
1713
X
1695
(FOV)
1693
(PLIB)

FIG. 47C

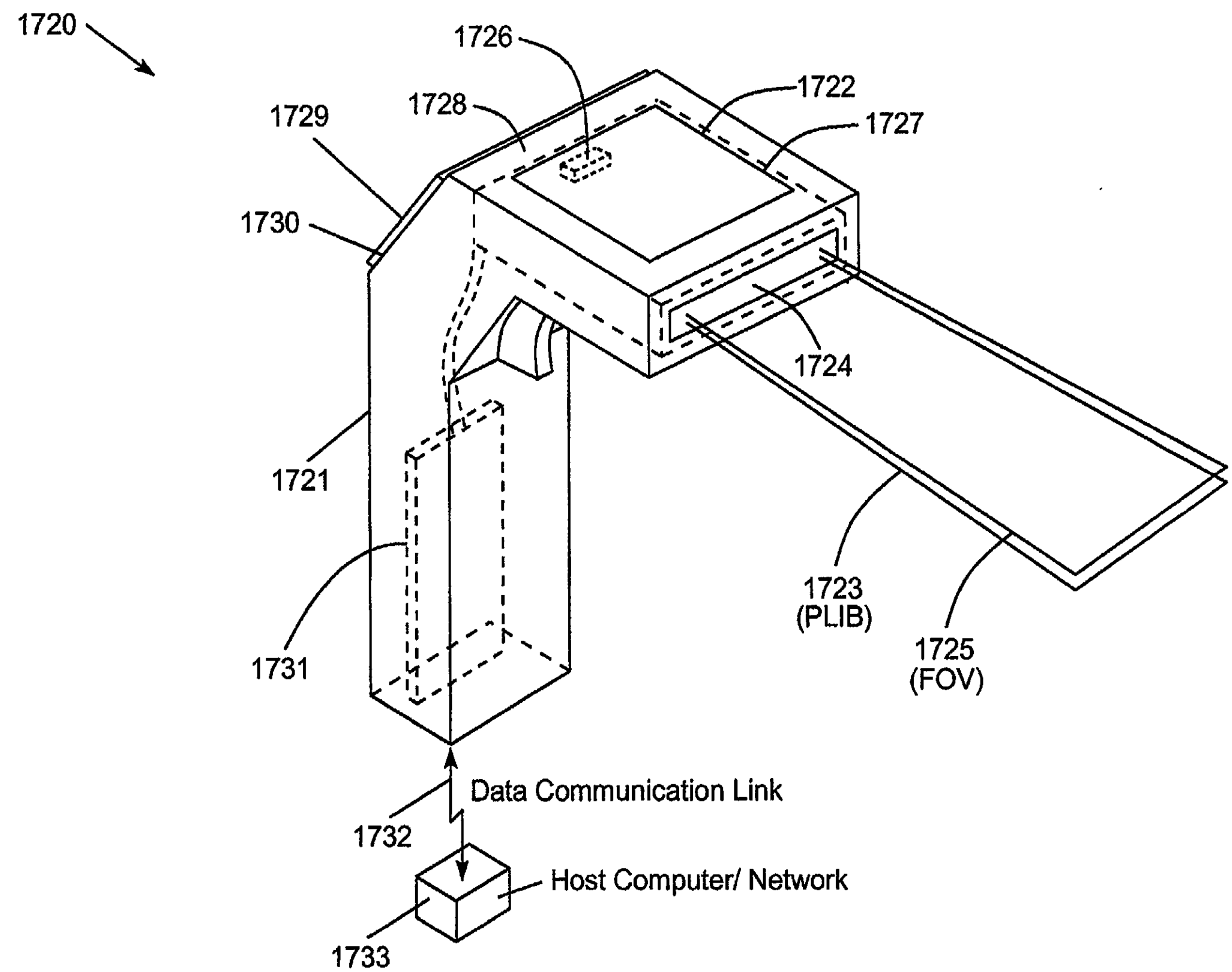
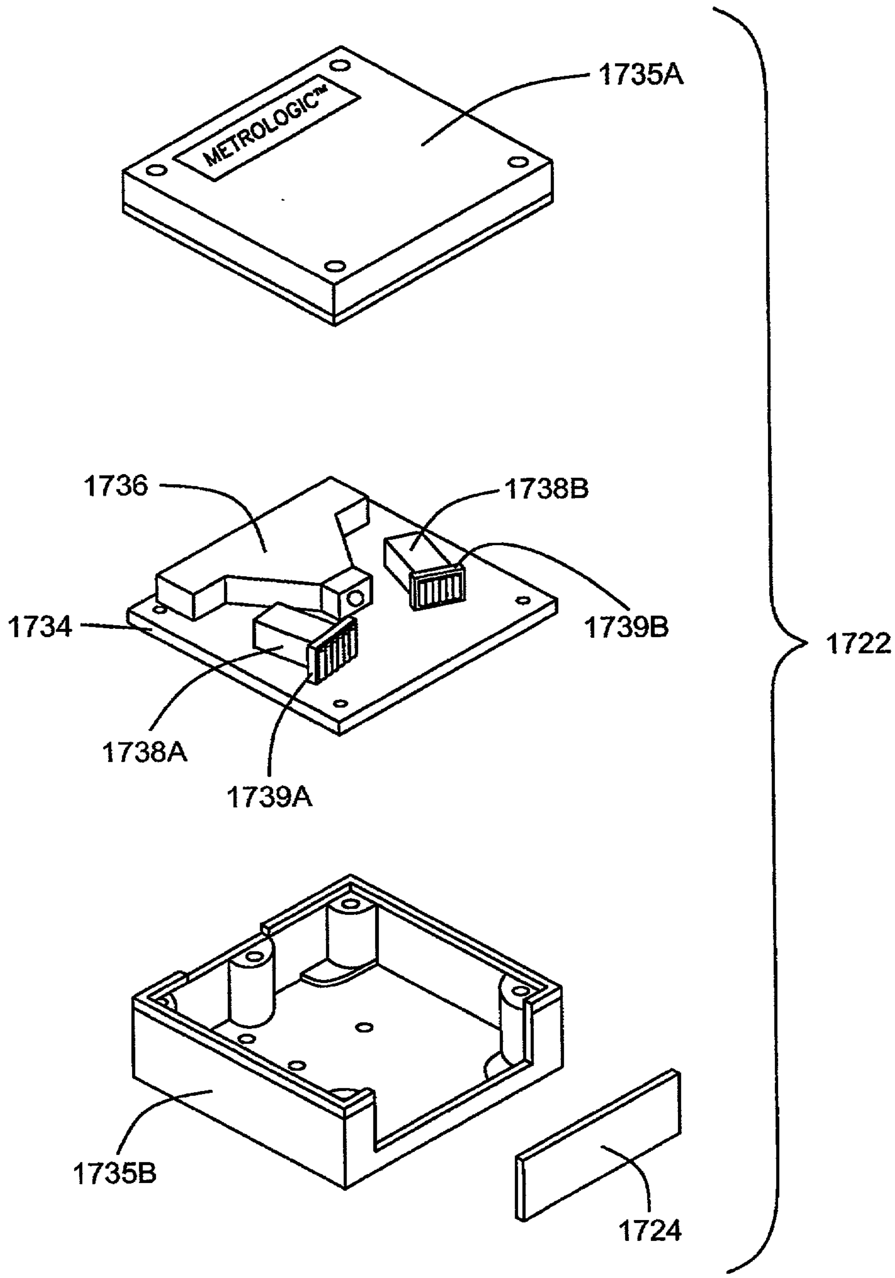

1720
1726
1722
1727
1728
1729
1730
1724
1721
1731
1723
(PLIB)
1725
(FOV)
Data Communication Link
1732
Host Computer/ Network
1733

FIG. 48A



METROLOGIC™
1735A
1736
1738B
1734
1739B
1722
1738A
1739A
1735B
1724

FIG. 48B

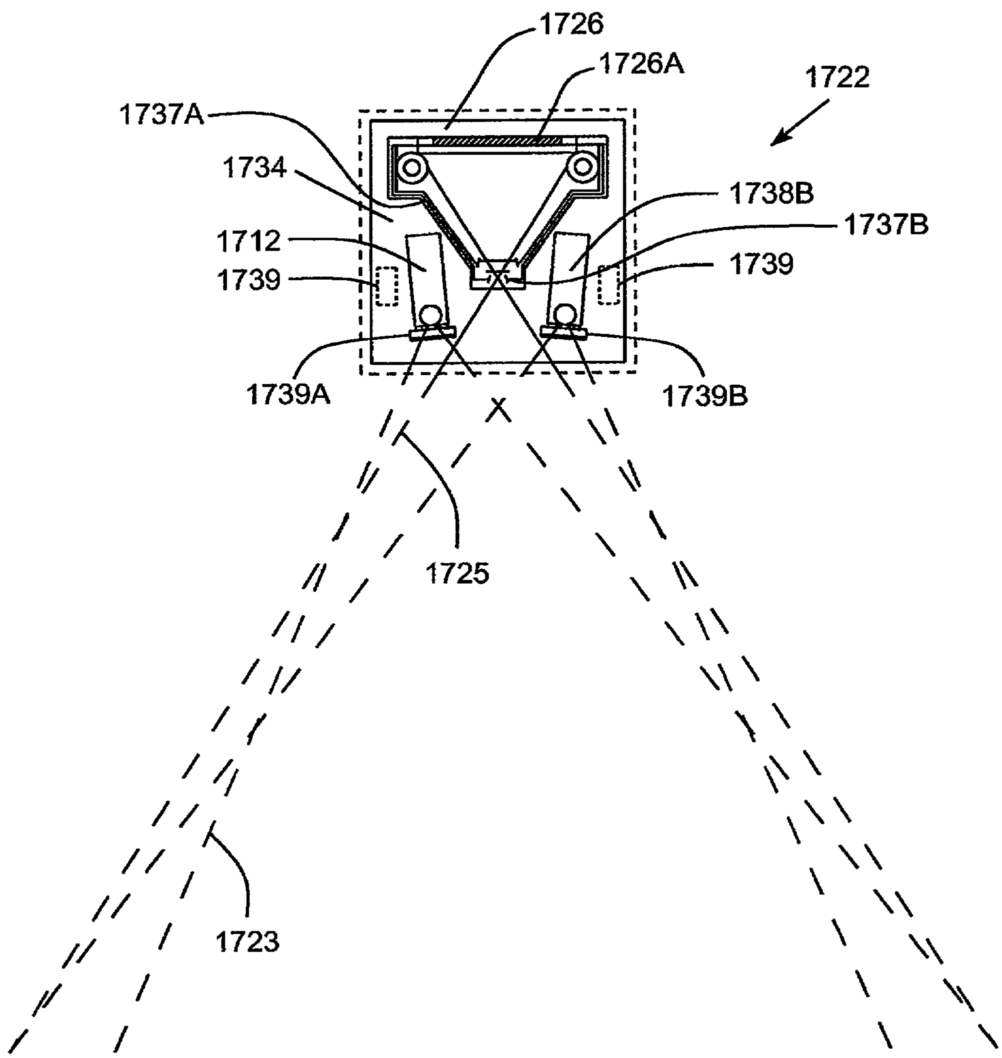

1726
1726A
1722
1737A
1734
1738B
1737B
1712
1739
1739
1739A
1739B
1725
1723

FIG. 48C

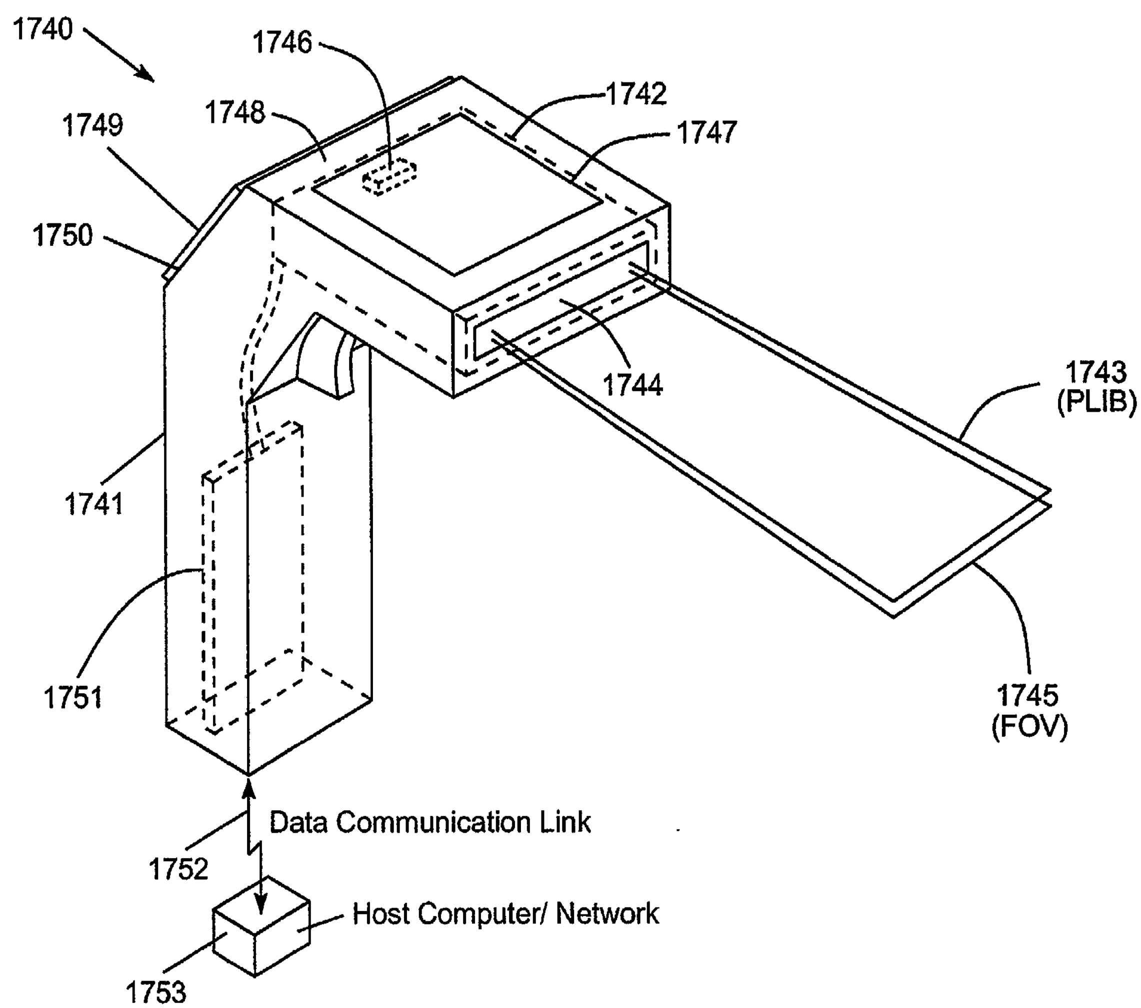

1740
1746
1742
1748
1747
1749
1750
1744
1743
(PLIB)
1741
1751
1745
(FOV)
Data Communication Link
1752
Host Computer/ Network
1753

FIG. 49A

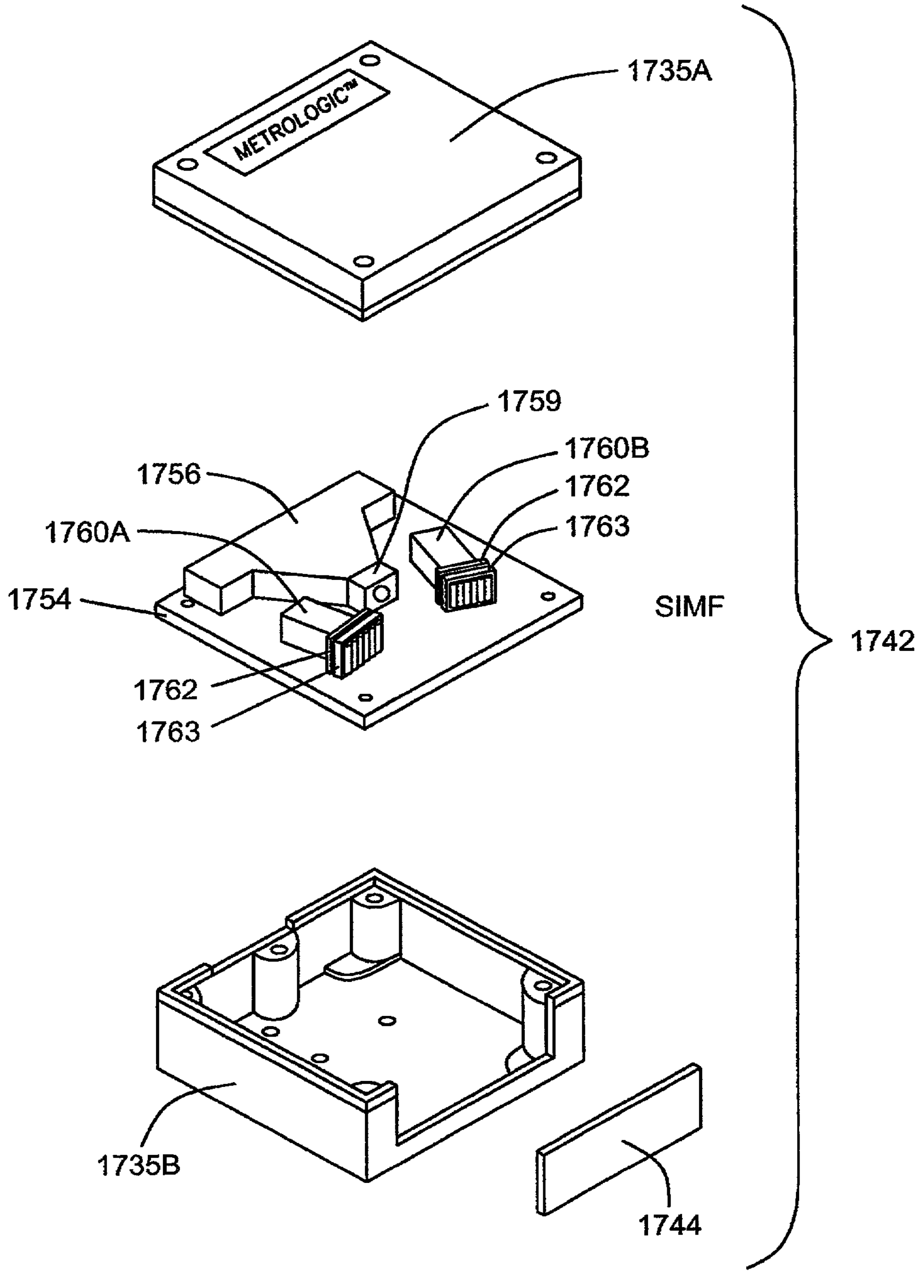

1735A
METROLOGIC™
1759
1760B
1756
1762
1760A
1763
1754
SIMF
1742
1762
1763
1735B
1744

FIG. 49B

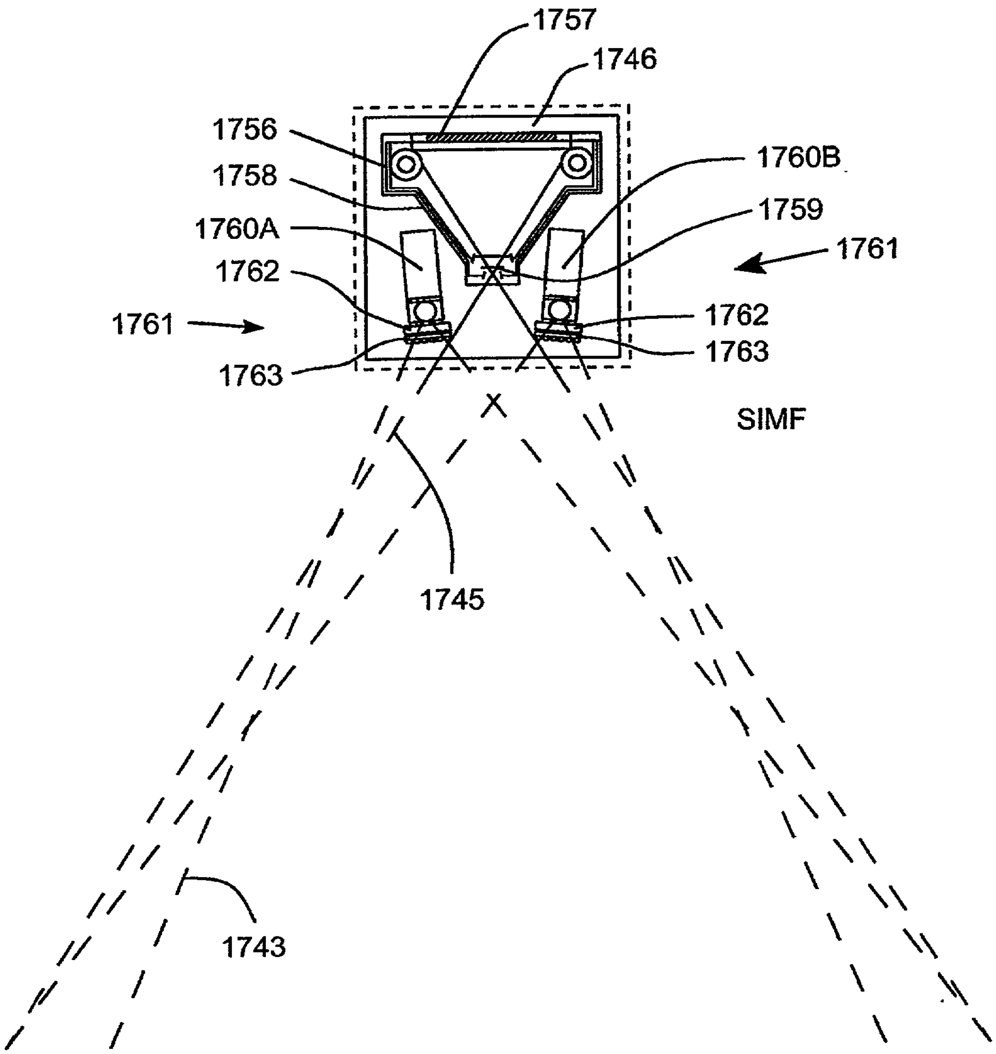

1757
1746
1756
1758
1760B
1759
1760A
1761
1762
1761
1762
1763
1763
SIMF
1745
1743

FIG. 49C

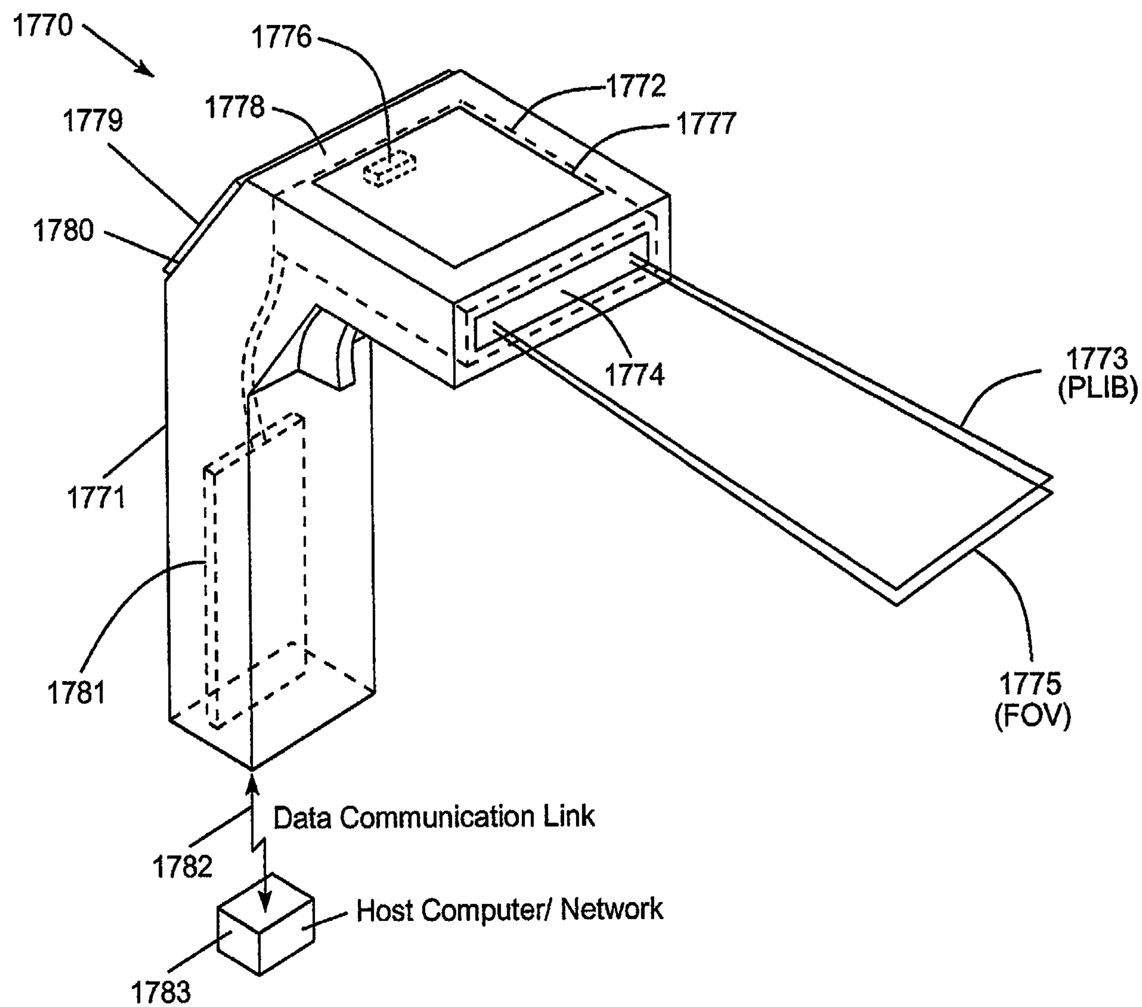
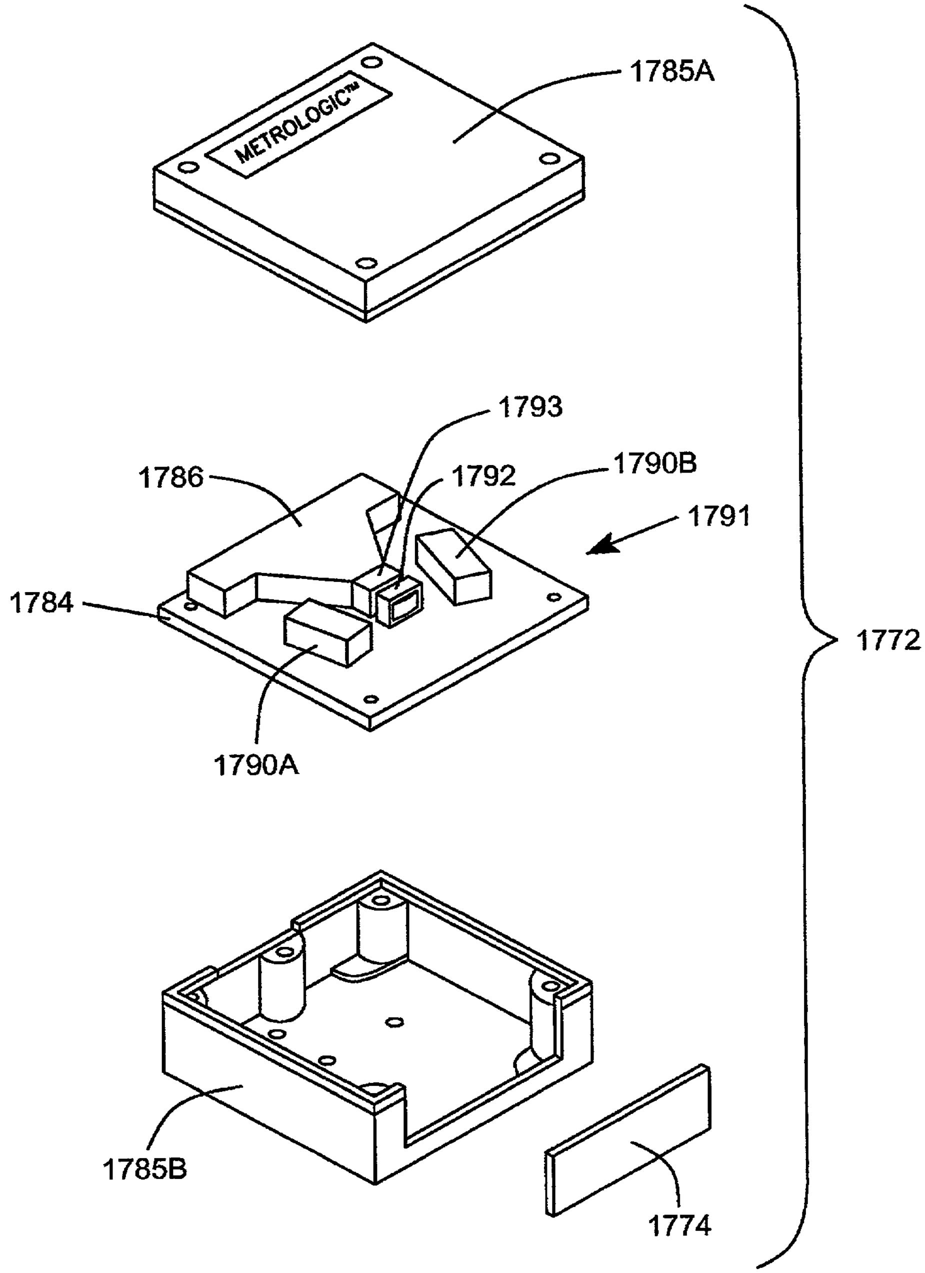

1770
1776
1772
1777
1778
1779
1780
1774
1773
(PLIB)
1771
1781
1775
(FOV)
Data Communication Link
1782
Host Computer/ Network
1783

FIG. 50A



1785A
METROLOGIC™
1793
1786
1792
1790B
1791
1784
1772
1790A
1785B
1774

FIG. 50B

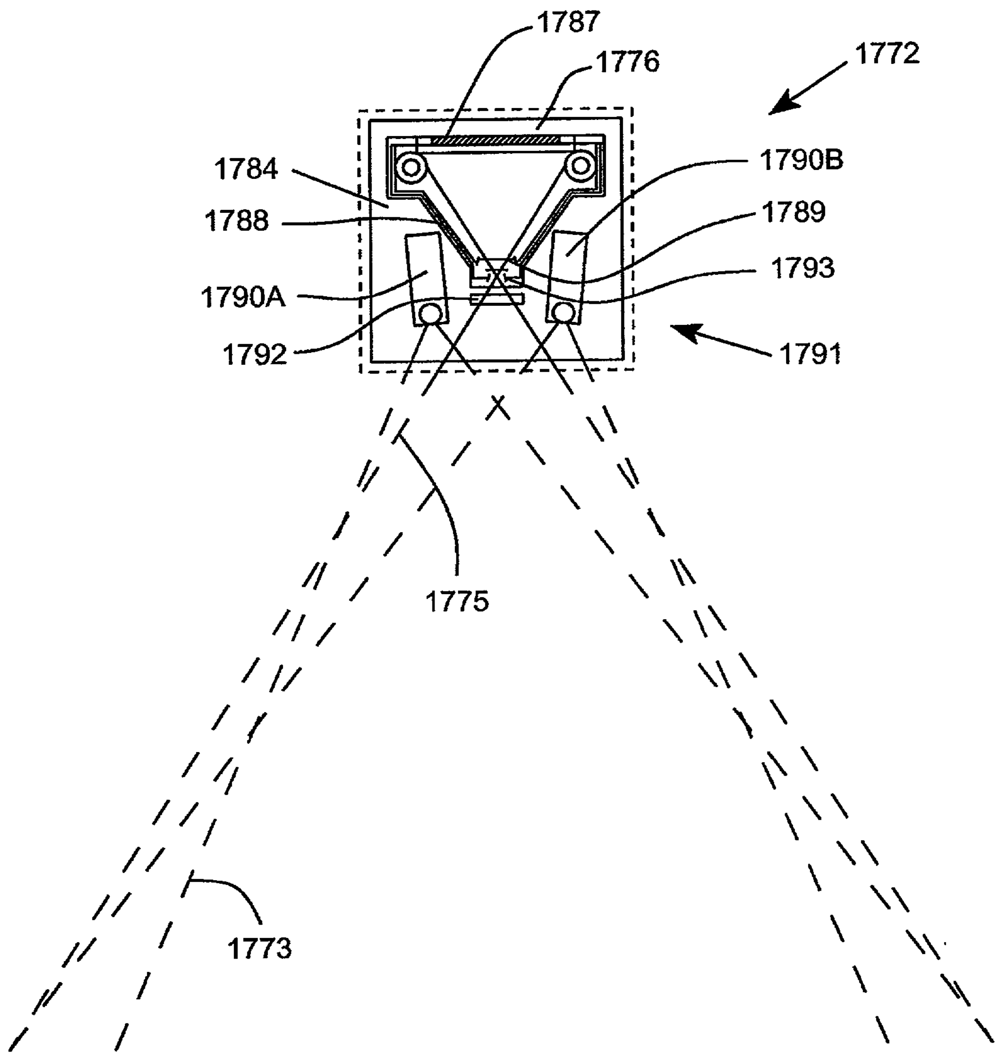

1787
1776
1772
1784
1790B
1788
1789
1790A
1793
1792
1791
1775
1773

FIG. 50C

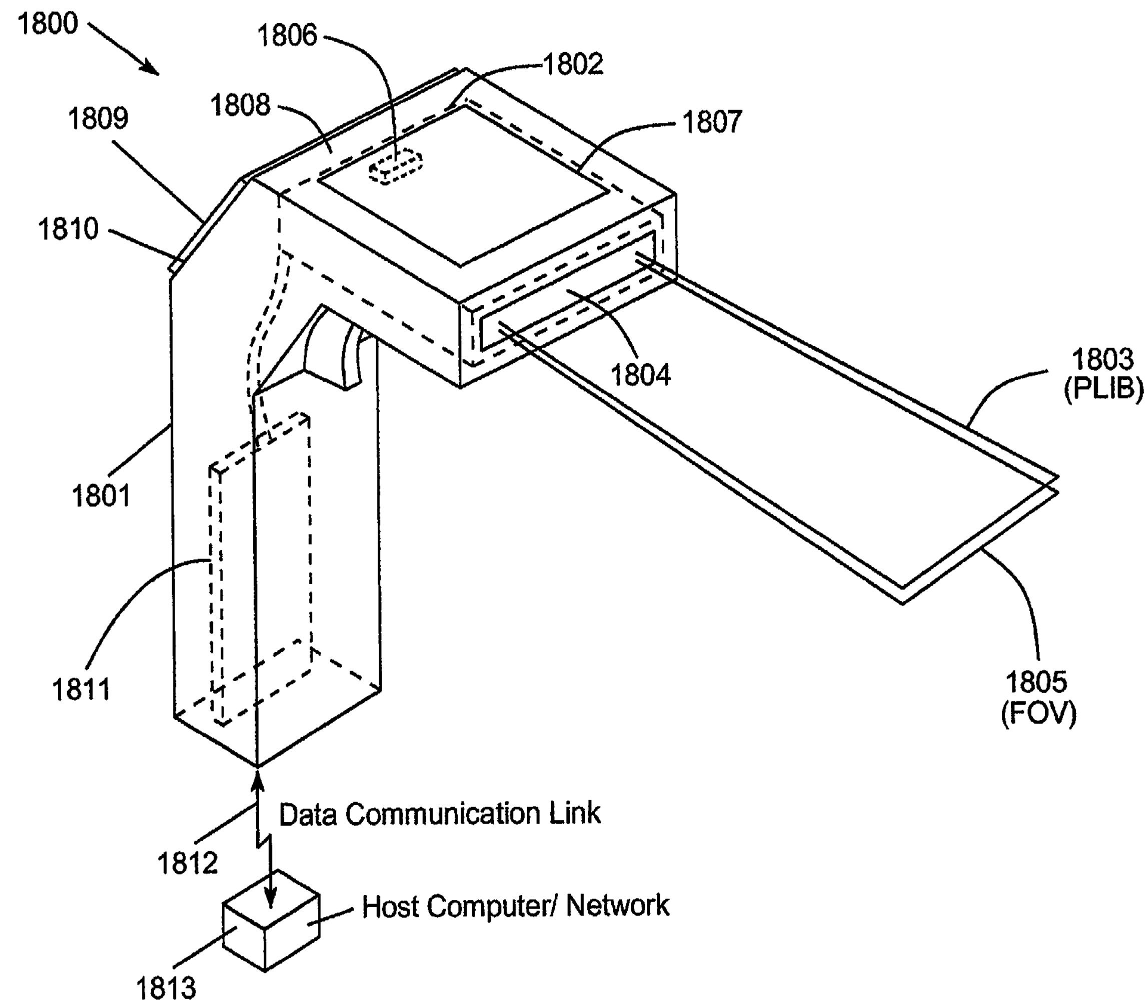

1800
1806
1802
1808
1807
1809
1810
1804
1803
(PLIB)
1801
1811
1805
(FOV)
Data Communication Link
1812
Host Computer/ Network
1813

FIG. 51A

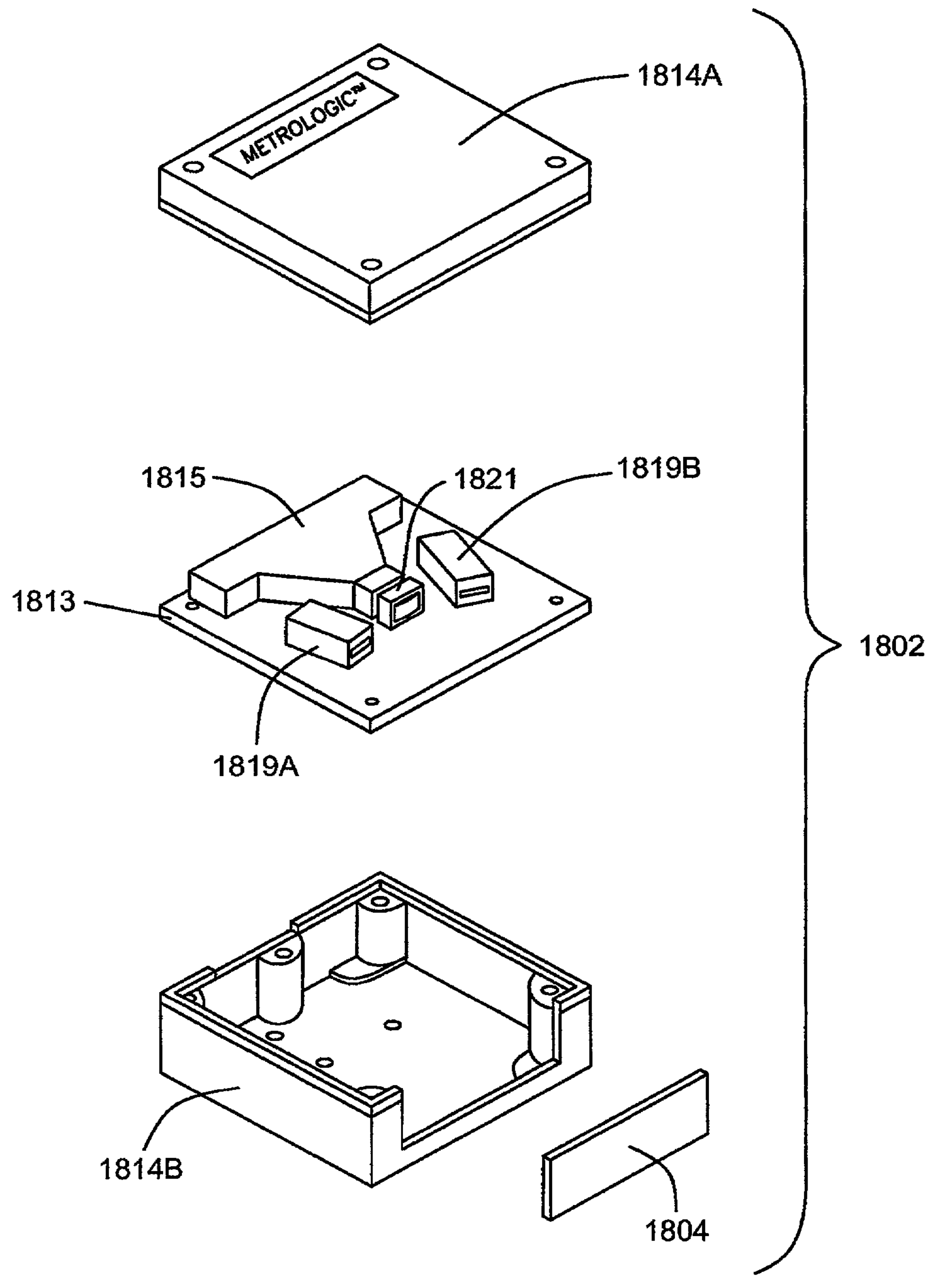

1814A
METROLOGIC™
1815
1821
1819B
1813
1802
1819A
1814B
1804

FIG. 51B

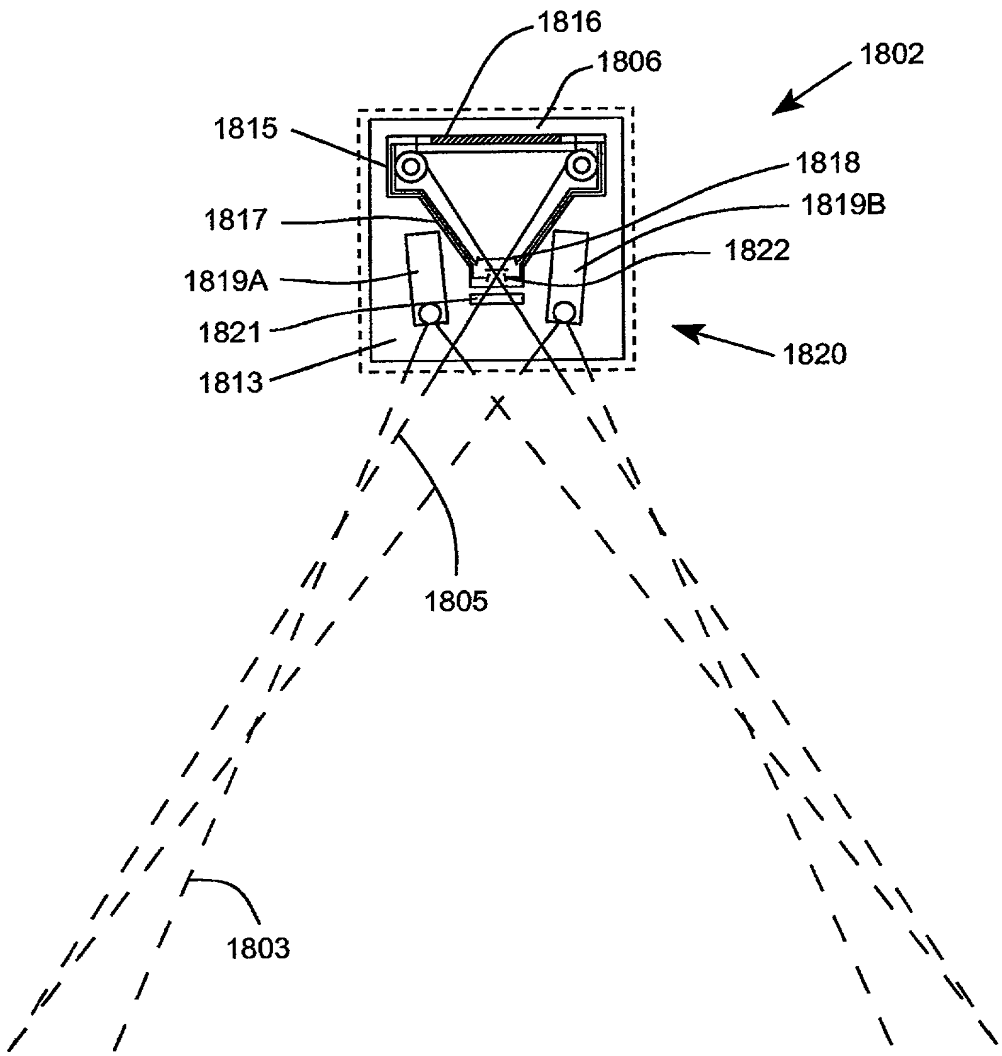

1816
1806
1802
1815
1818
1817
1819B
1822
1819A
1821
1820
1813
1805
1803

FIG. 51C

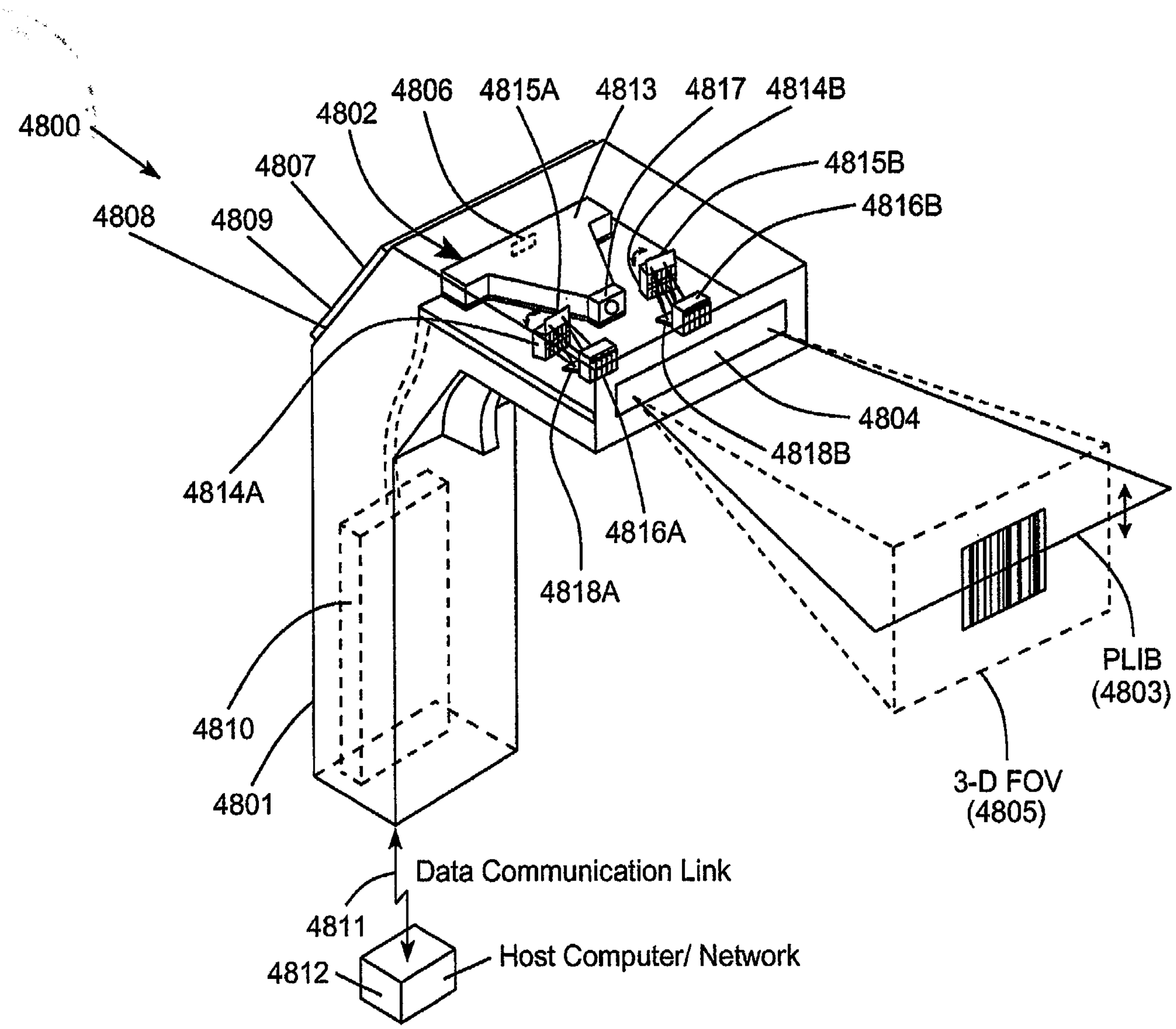
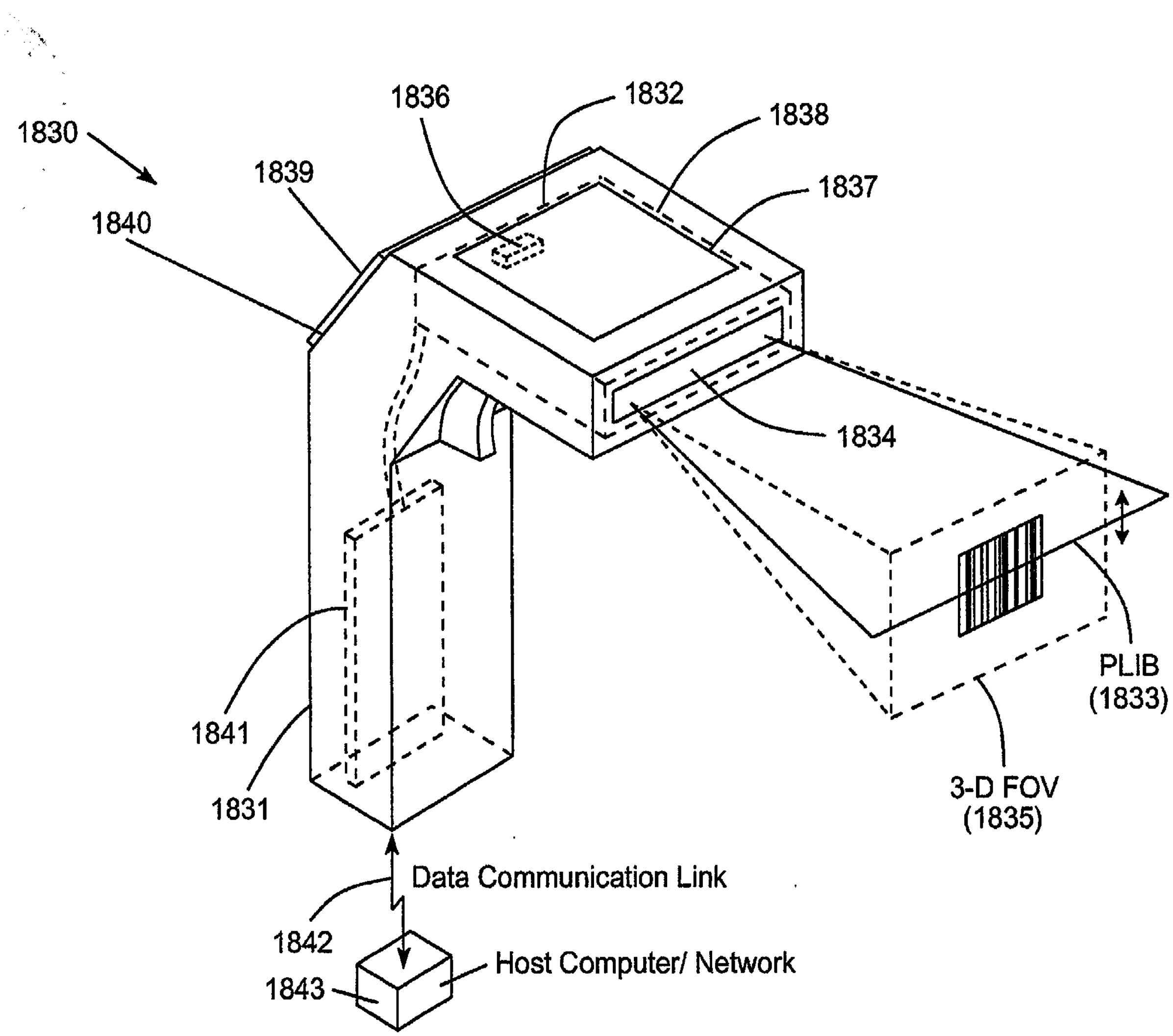

4800
4808
4809
4807
4802
4806
4815A
4813
4817
4814B
4815B
4816B
4804
4818B
4814A
4816A
4818A
4810
4801
PLIB
(4803)
3-D FOV
(4805)
Data Communication Link
4811
4812
Host Computer/ Network

FIG. 52


1830
1836
1832
1838
1837
1839
1840
1834
PLIB
(1833)
3-D FOV
(1835)
1841
1831
Data Communication Link
1842
1843
Host Computer/ Network
FIG. 52A

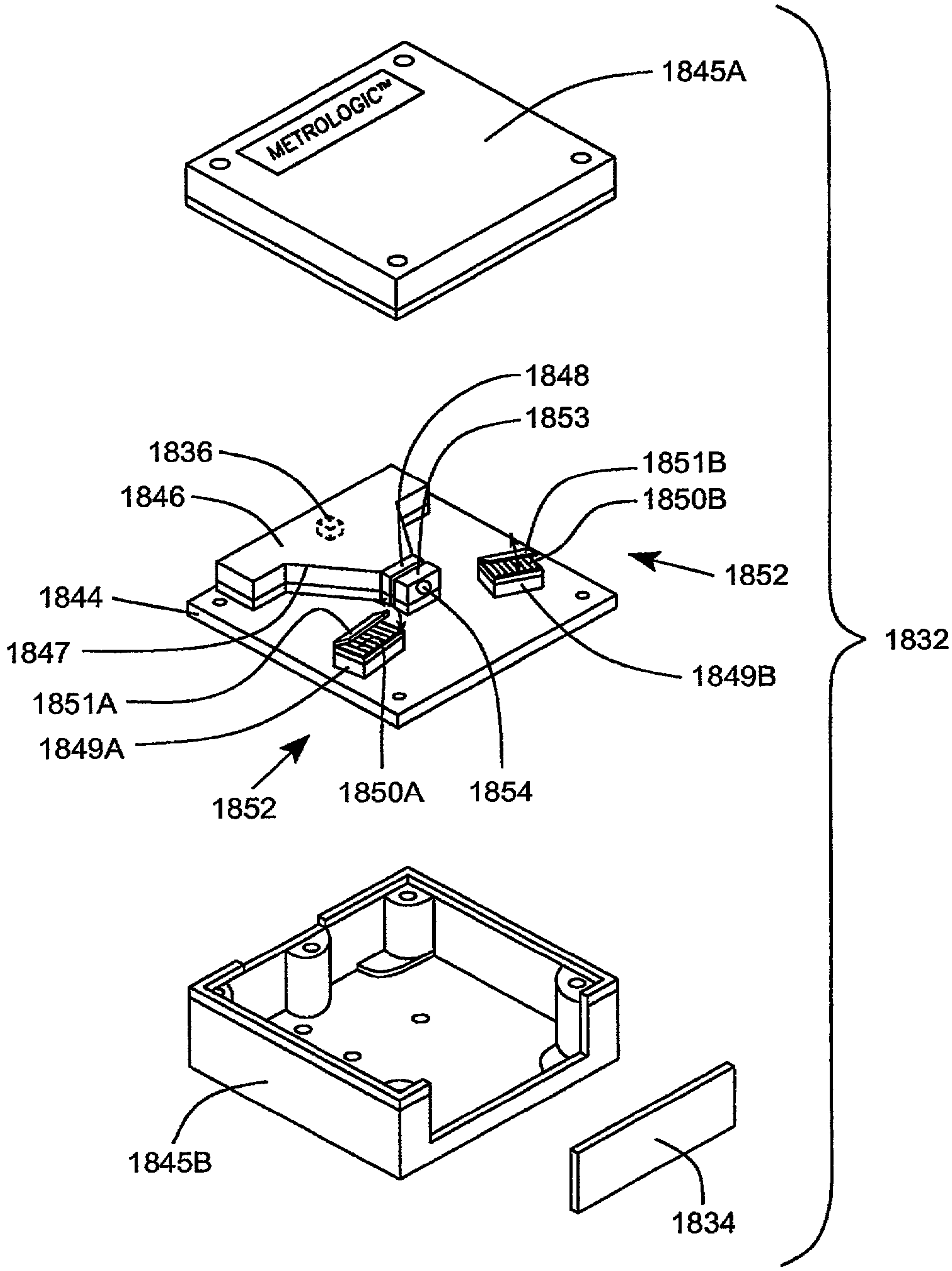


Fig. 1I3A-3B

FIG. 52B

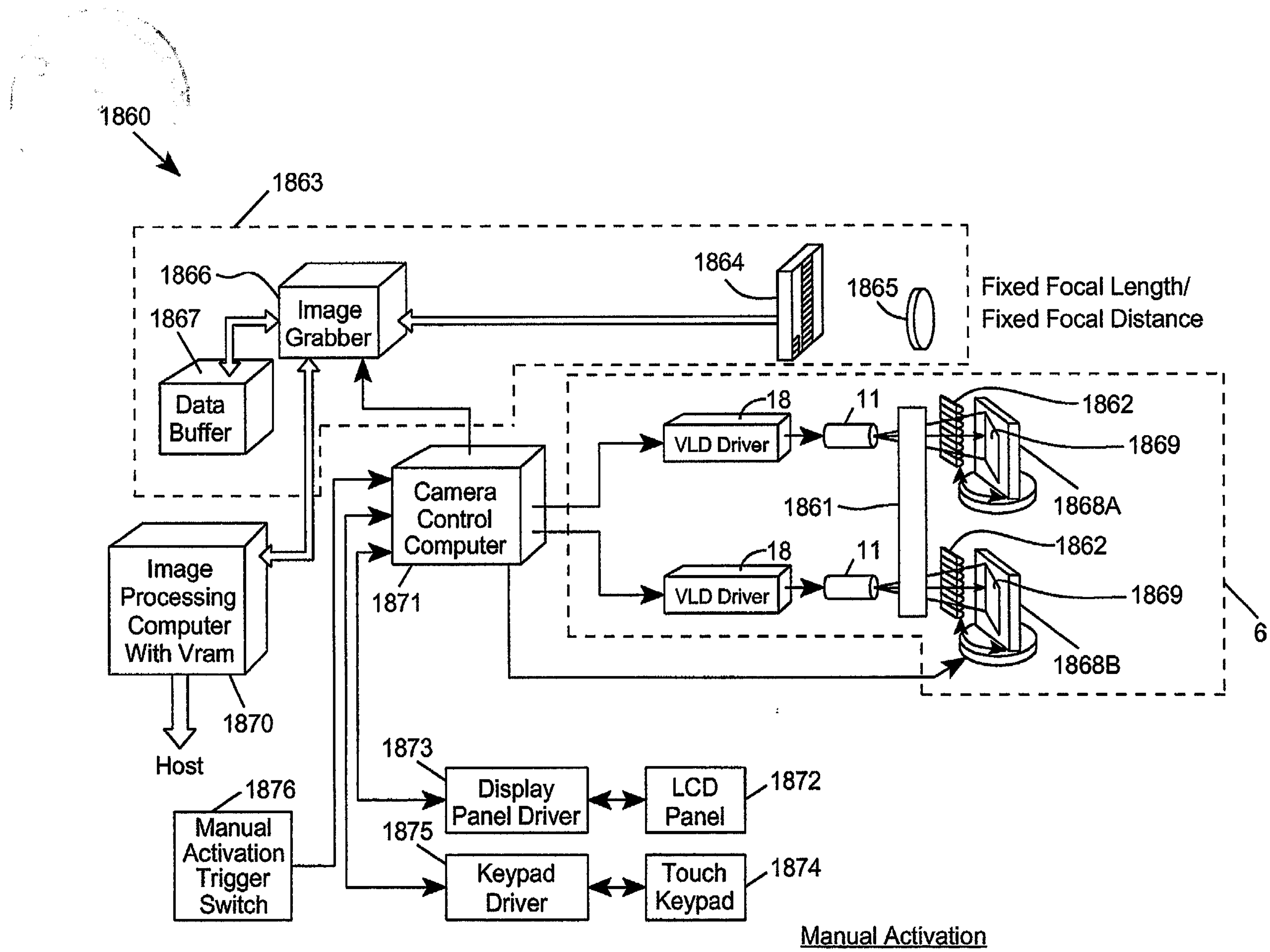

1860
1863
1866
1867
Image Grabber
Data Buffer
1864
1865
Fixed Focal Length/
Fixed Focal Distance
18
11
VLD Driver
1862
1869
1868A
1861
1868B
6
Camera Control Computer
1871
Image Processing Computer With Vram
1870
Host
1876
Manual Activation Trigger Switch
1873
Display Panel Driver
LCD Panel
1872
1875
Keypad Driver
Touch Keypad
1874
Manual Activation

FIG. 53A1

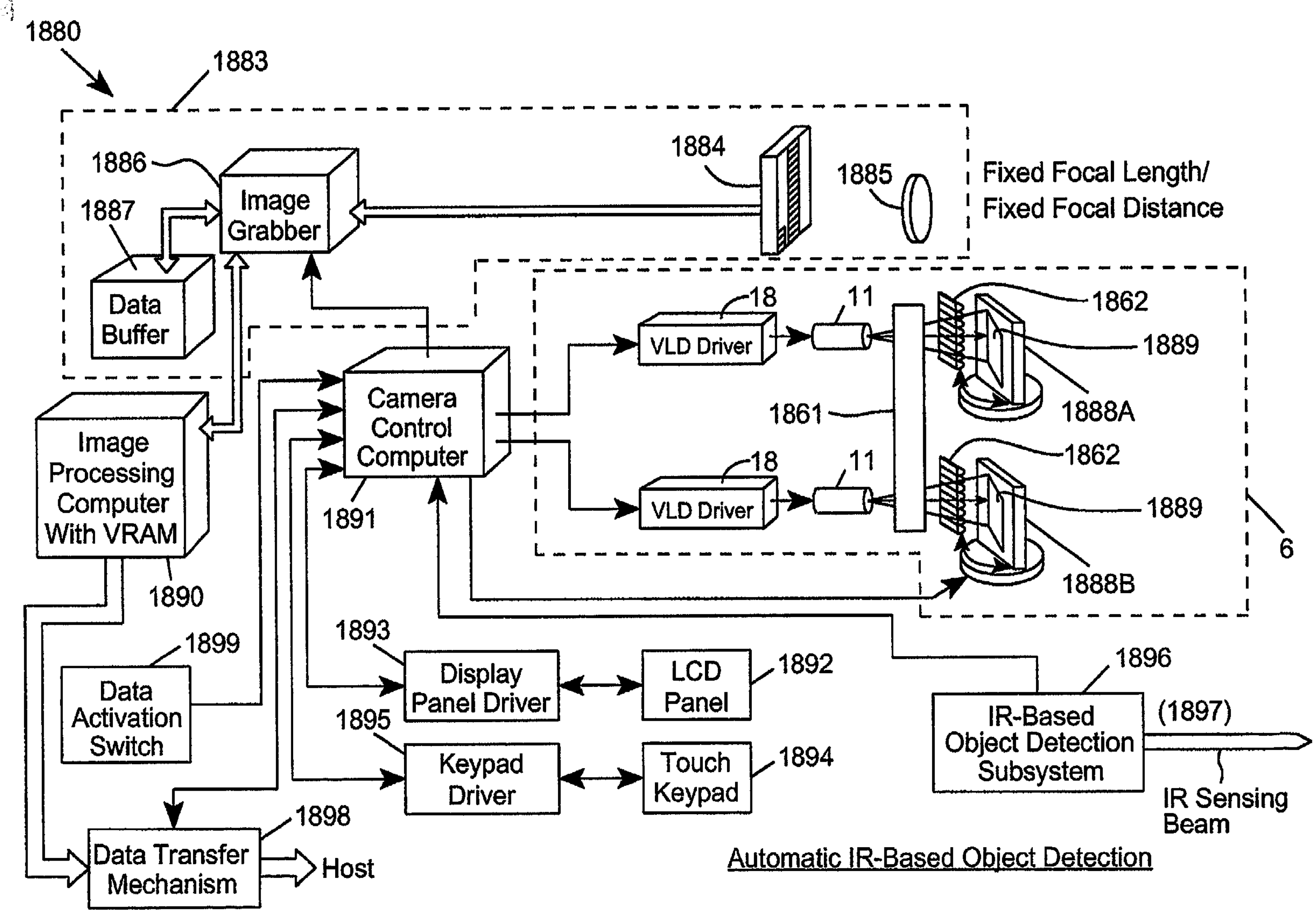

1880
1883
1886
1887
Image Grabber
Data Buffer
1884
1885
Fixed Focal Length/
Fixed Focal Distance
Image Processing Computer With VRAM
1890
Camera Control Computer
1891
18
VLD Driver
11
1861
1862
1889
1888A
1888B
6
1899
Data Activation Switch
1893
Display Panel Driver
LCD Panel
1892
1895
Keypad Driver
Touch Keypad
1894
1896
IR-Based Object Detection Subsystem
(1897)
IR Sensing Beam
1898
Data Transfer Mechanism
Host
Automatic IR-Based Object Detection

FIG. 53A2

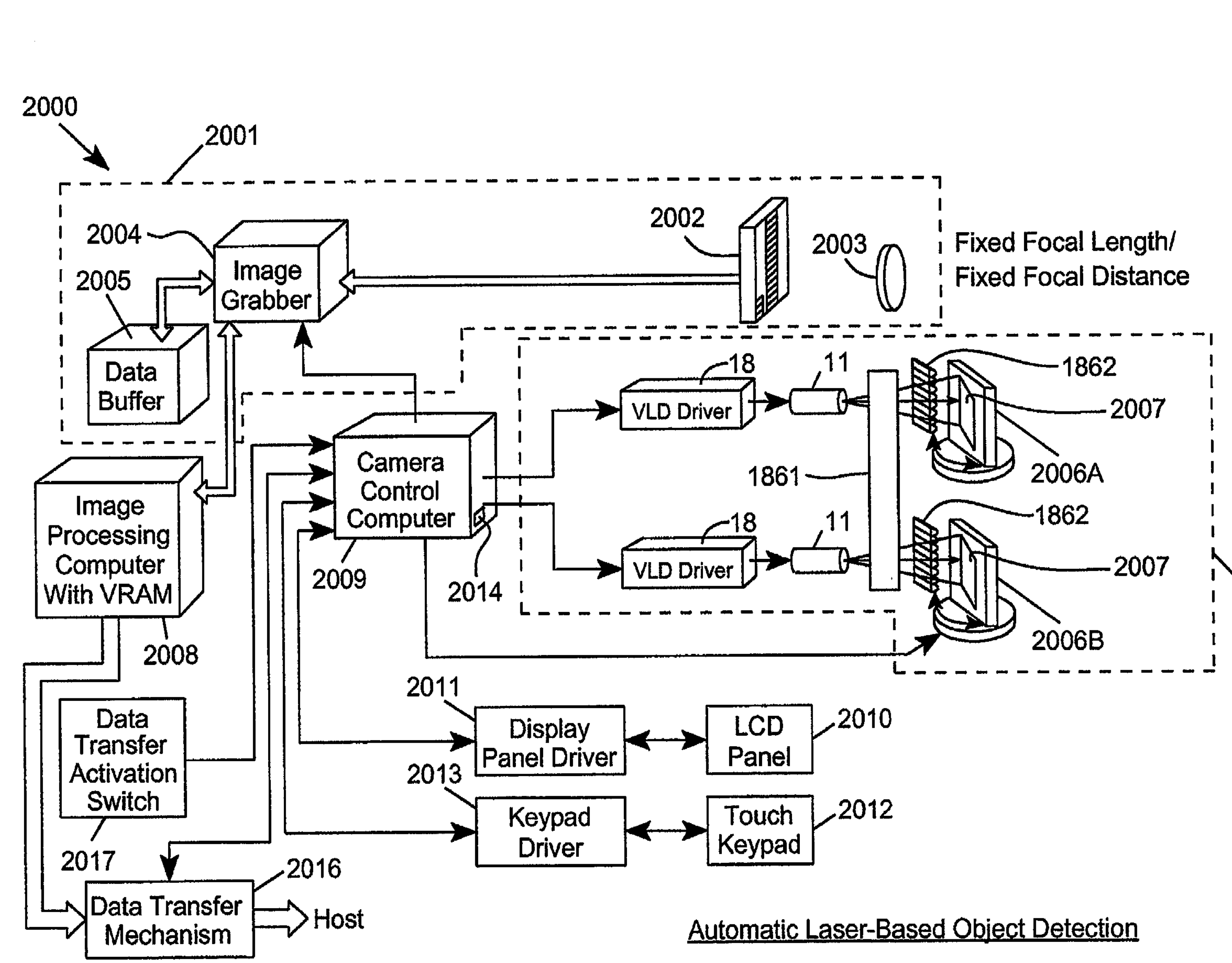

2000
2001
2004
2005
Image Grabber
Data Buffer
2002
2003
Fixed Focal Length/
Fixed Focal Distance
Image Processing Computer With VRAM
2008
Camera Control Computer
2009
2014
18
VLD Driver
11
1861
1862
2007
2006A
2006B
6
Data Transfer Activation Switch
2017
Data Transfer Mechanism
2016
Host
2011
Display Panel Driver
LCD Panel
2010
2013
Keypad Driver
Touch Keypad
2012
Automatic Laser-Based Object Detection

FIG. 53A3

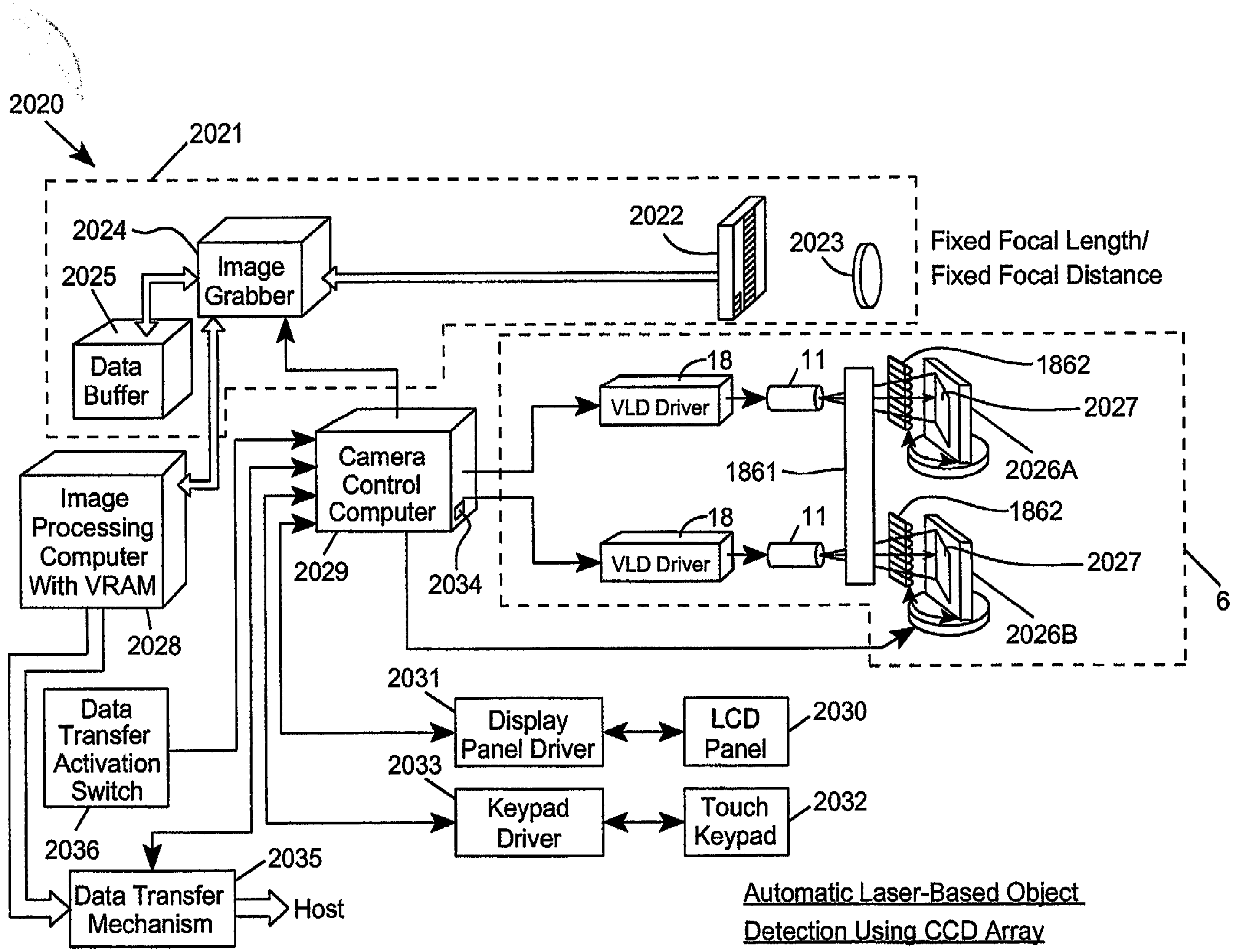

2020
2021
2024
Image Grabber
2025
Data Buffer
2022
2023
Fixed Focal Length/
Fixed Focal Distance
Image Processing Computer With VRAM
2028
Camera Control Computer
2029
2034
18
VLD Driver
11
1861
1862
2027
2026A
2026B
6
Data Transfer Activation Switch
2036
Data Transfer Mechanism
2035
Host
2031
Display Panel Driver
LCD Panel
2030
2033
Keypad Driver
Touch Keypad
2032
Automatic Laser-Based Object
Detection Using CCD Array

FIG. 53A4

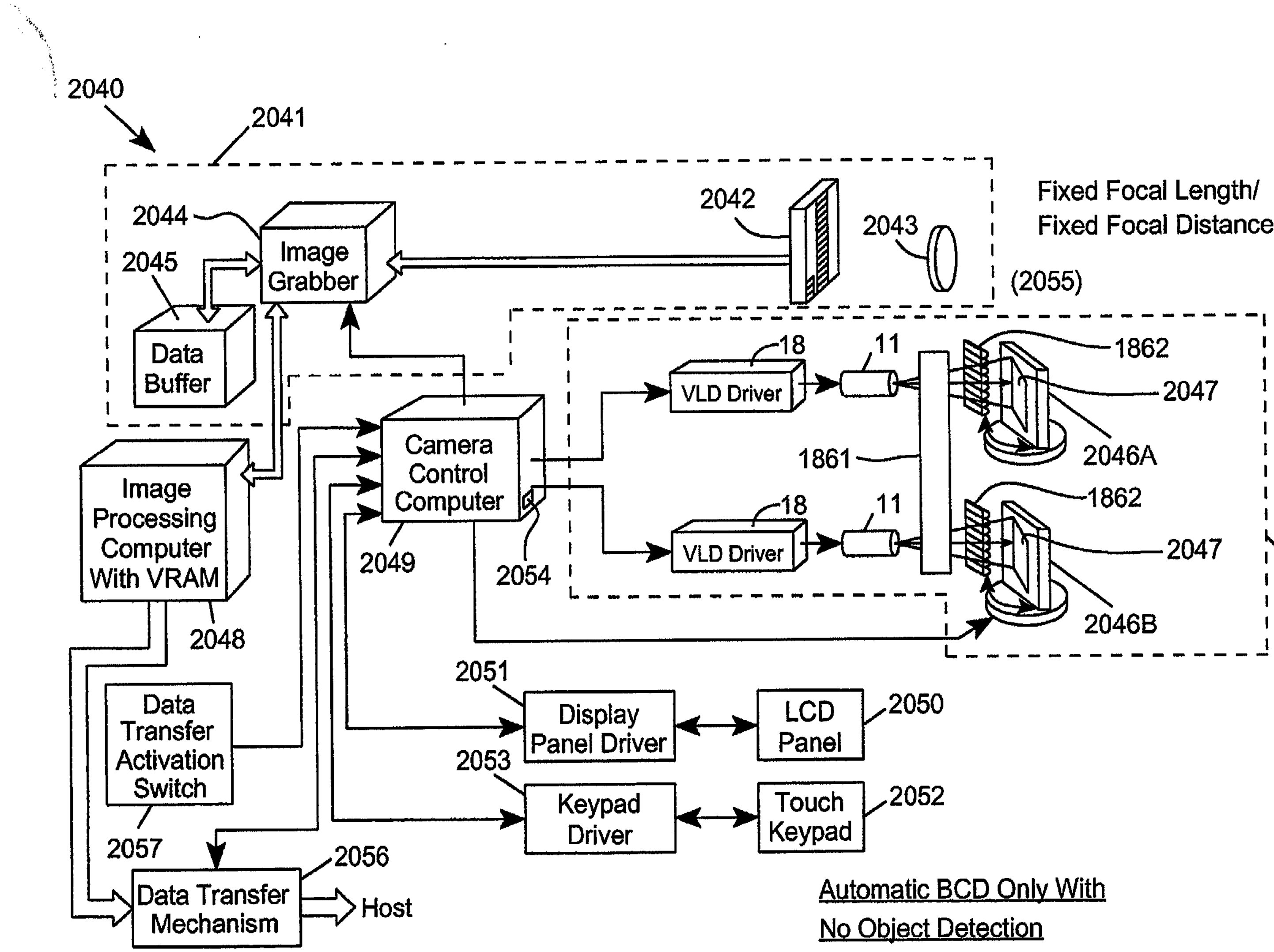

2040
2041
2044
2045
Image Grabber
Data Buffer
2042
2043
Fixed Focal Length/
Fixed Focal Distance
(2055)
Image Processing Computer With VRAM
2048
Camera Control Computer
2049
2054
18
VLD Driver
11
1861
1862
2047
2046A
2046B
6
2051
Display Panel Driver
LCD Panel
2050
2053
Keypad Driver
Touch Keypad
2052
Data Transfer Activation Switch
2057
Data Transfer Mechanism
2056
Host
Automatic BCD Only With
No Object Detection

FIG. 53A5

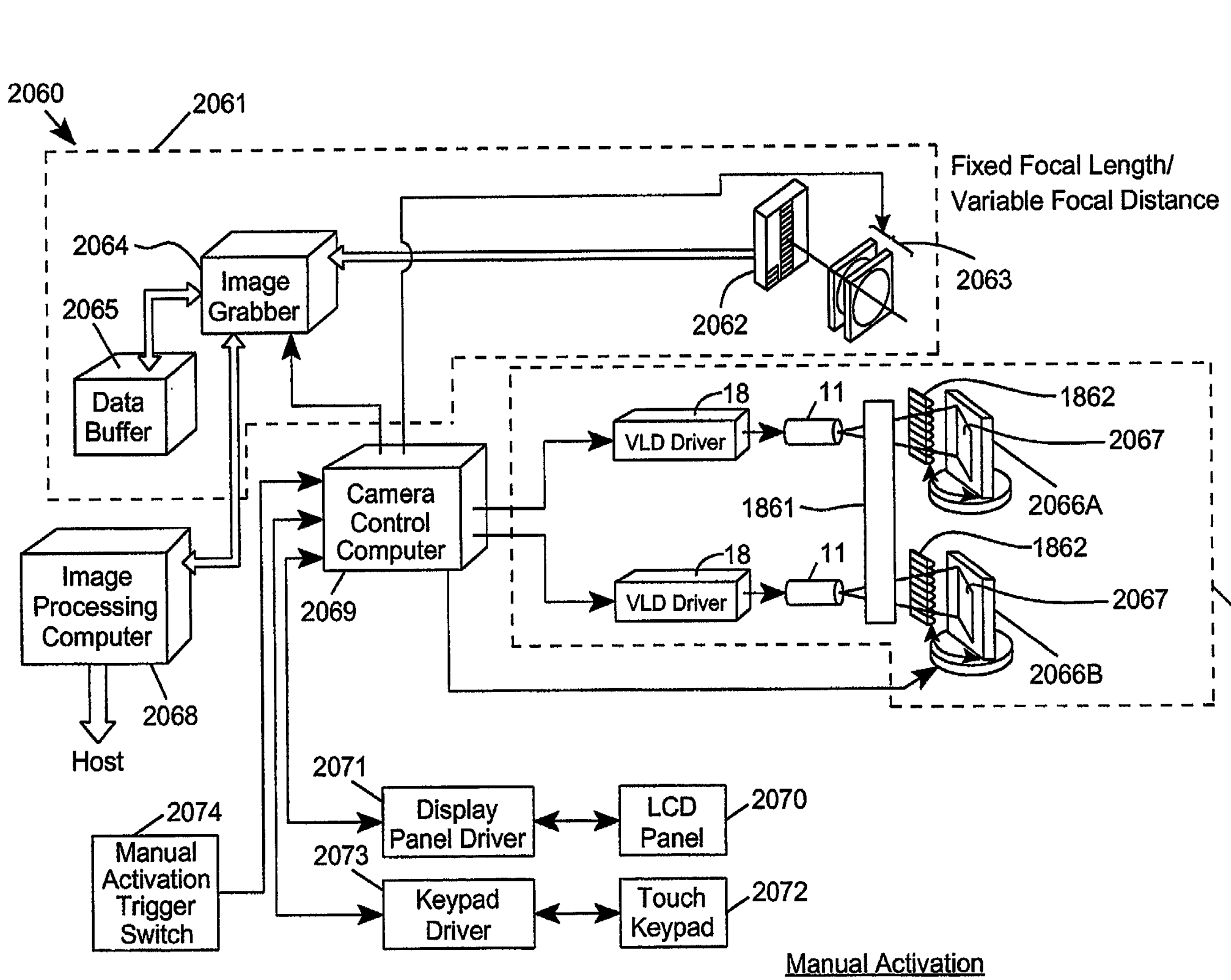

2060
2061
Fixed Focal Length/
Variable Focal Distance
2064
Image
Grabber
2065
Data
Buffer
2062
2063
18
11
1862
VLD Driver
2067
2066A
1861
Camera
Control
Computer
18
11
1862
VLD Driver
2067
6
2066B
Image
Processing
Computer
2069
2068
Host
2071
Display
Panel Driver
LCD
Panel
2070
2074
Manual
Activation
Trigger
Switch
2073
Keypad
Driver
Touch
Keypad
2072
Manual Activation

FIG. 53B1

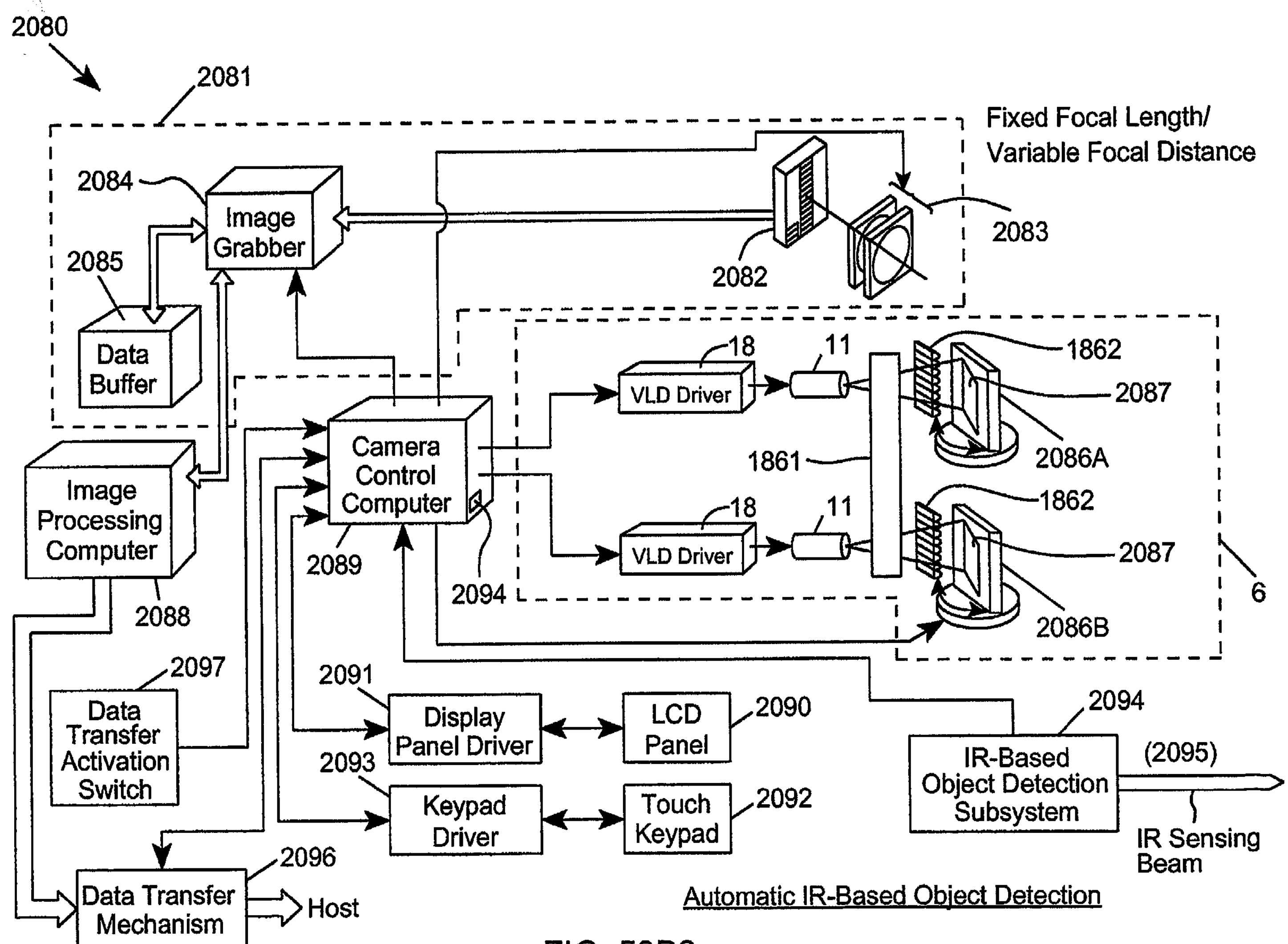

2080
2081
Fixed Focal Length/
Variable Focal Distance
2084
Image
Grabber
2085
Data
Buffer
2082
2083
Image
Processing
Computer
2088
Camera
Control
Computer
2089
2094
18
VLD Driver
11
1862
2087
2086A
1861
18
VLD Driver
11
1862
2087
2086B
6
2097
Data
Transfer
Activation
Switch
2091
Display
Panel Driver
LCD
Panel
2090
2093
Keypad
Driver
Touch
Keypad
2092
2094
IR-Based
Object Detection
Subsystem
(2095)
IR Sensing
Beam
2096
Data Transfer
Mechanism
Host
Automatic IR-Based Object Detection

FIG. 53B2

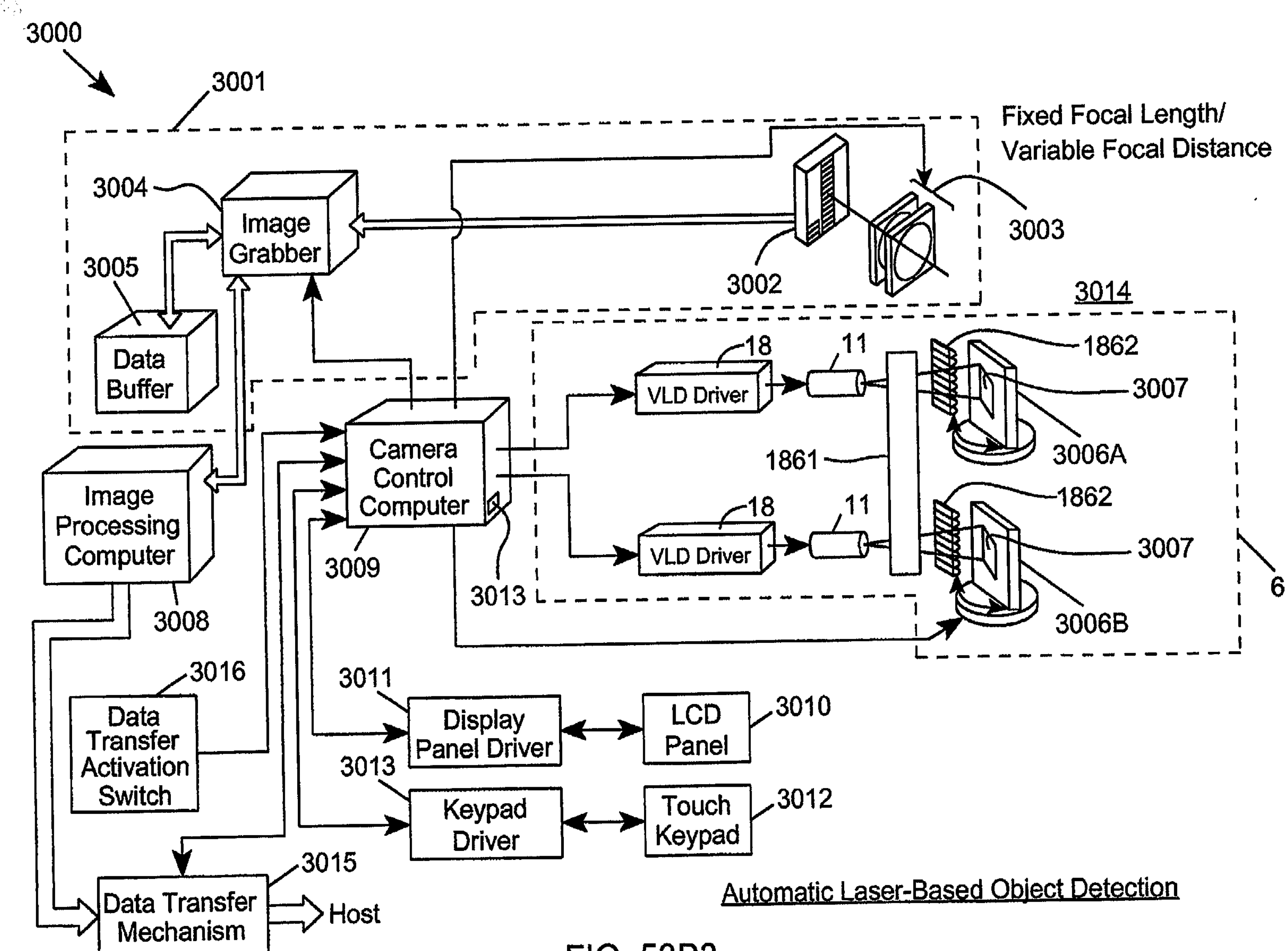

3000
3001
Fixed Focal Length/
Variable Focal Distance
3004
Image
Grabber
3005
Data
Buffer
3002
3003
3014
18
VLD Driver
11
1862
3007
3006A
1861
18
VLD Driver
11
1862
3007
3006B
6
Camera
Control
Computer
3009
3013
Image
Processing
Computer
3008
3016
Data
Transfer
Activation
Switch
3011
Display
Panel Driver
LCD
Panel
3010
3013
Keypad
Driver
Touch
Keypad
3012
3015
Data Transfer
Mechanism
Host
Automatic Laser-Based Object Detection

FIG. 53B3

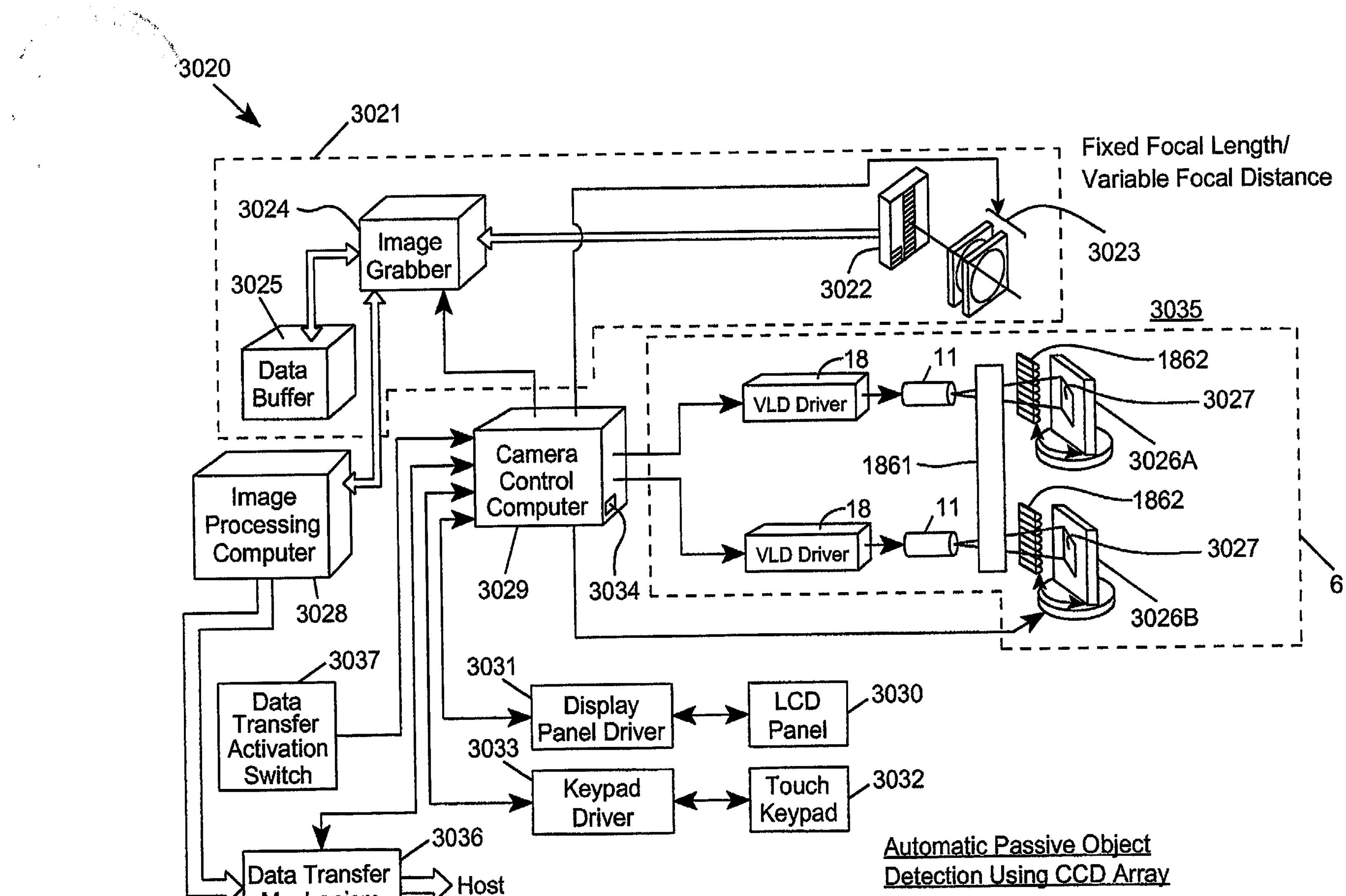

3020
3021
Fixed Focal Length/
Variable Focal Distance
3024
Image
Grabber
3025
Data
Buffer
3022
3023
3035
Image
Processing
Computer
3028
Camera
Control
Computer
3029
3034
18
VLD Driver
11
1861
1862
3027
3026A
3026B
6
3037
Data
Transfer
Activation
Switch
3031
Display
Panel Driver
LCD
Panel
3030
3033
Keypad
Driver
Touch
Keypad
3032
3036
Data Transfer
Mechanism
Host
Automatic Passive Object
Detection Using CCD Array

FIG. 53B4

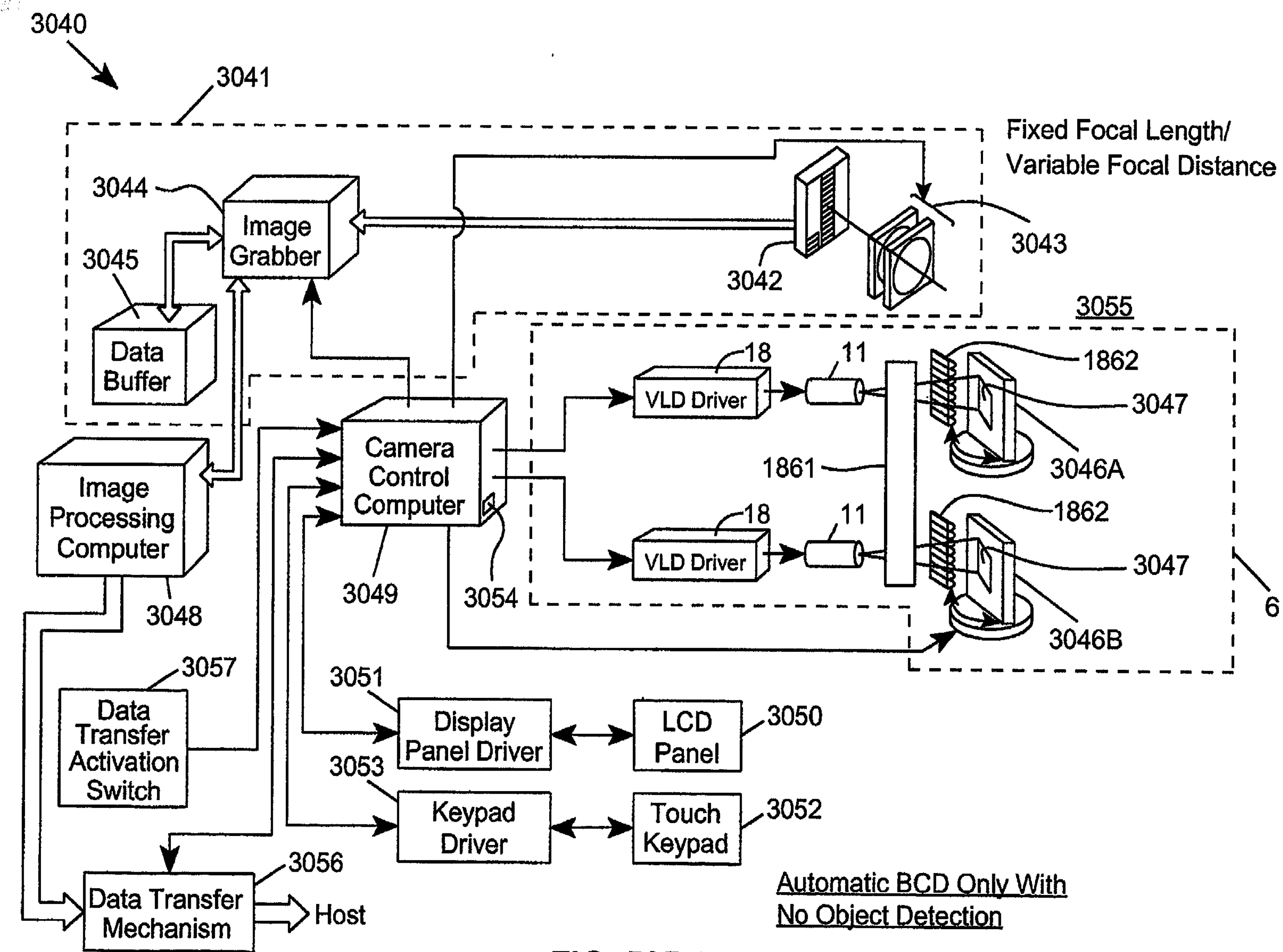
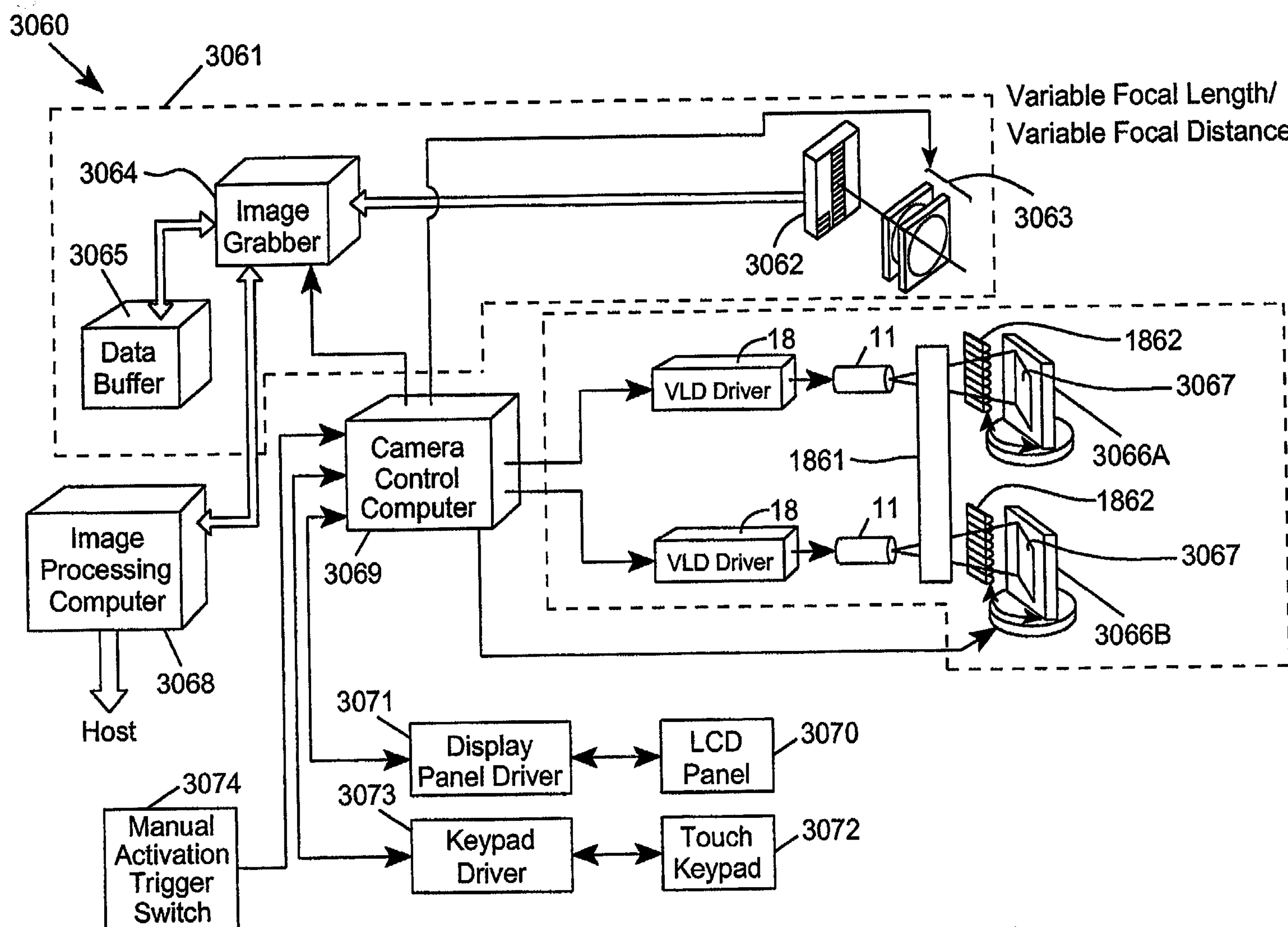

3040
3041
Fixed Focal Length/
Variable Focal Distance
3044
Image
Grabber
3045
Data
Buffer
3042
3043
3055
18
11
VLD Driver
1862
3047
3046A
1861
Image
Processing
Computer
Camera
Control
Computer
3049
3054
3048
3046B
6
3057
Data
Transfer
Activation
Switch
3051
Display
Panel Driver
LCD
Panel
3050
3053
Keypad
Driver
Touch
Keypad
3052
3056
Data Transfer
Mechanism
Host
Automatic BCD Only With
No Object Detection

FIG. 53B5



Manual Activation

FIG. 53C1

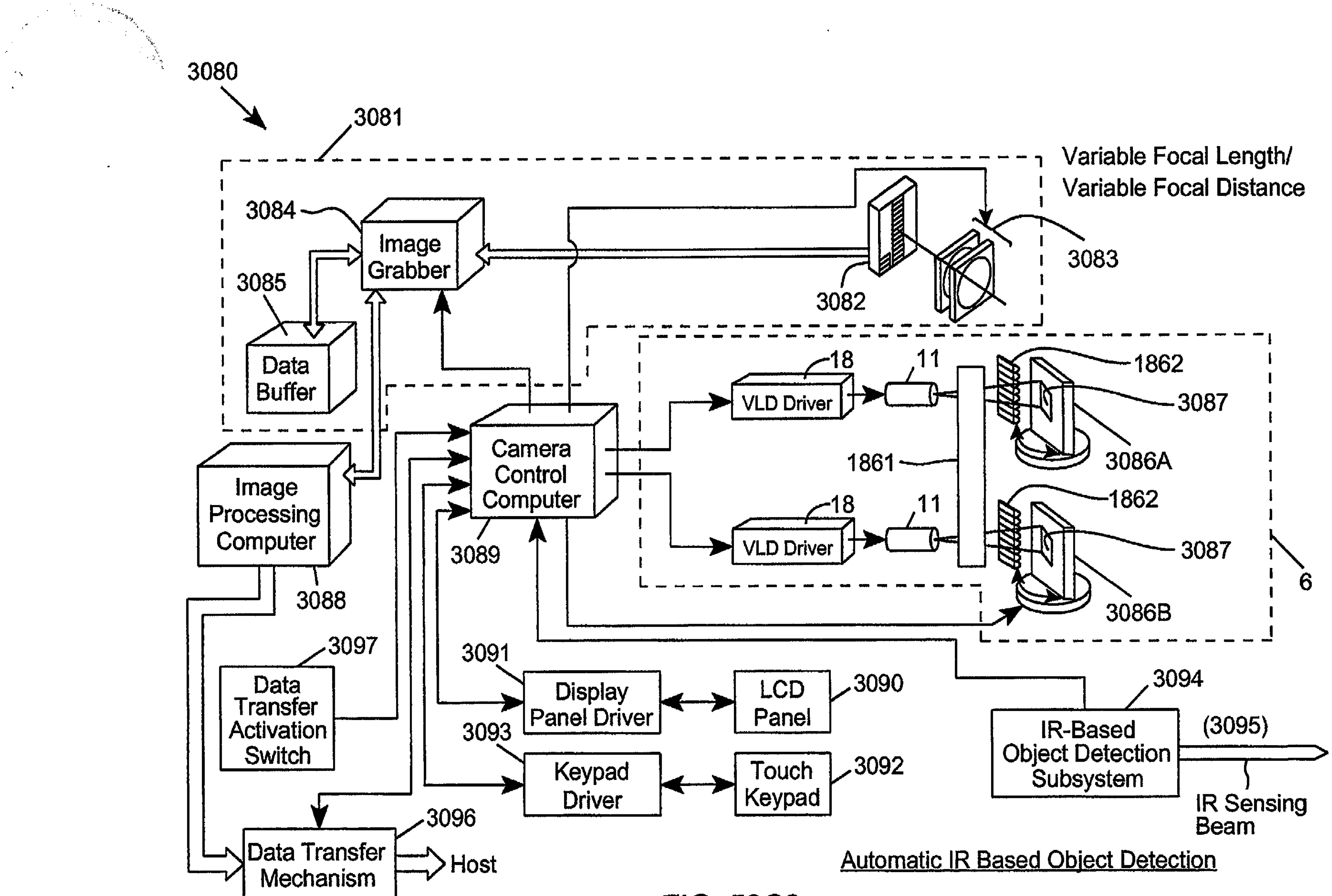
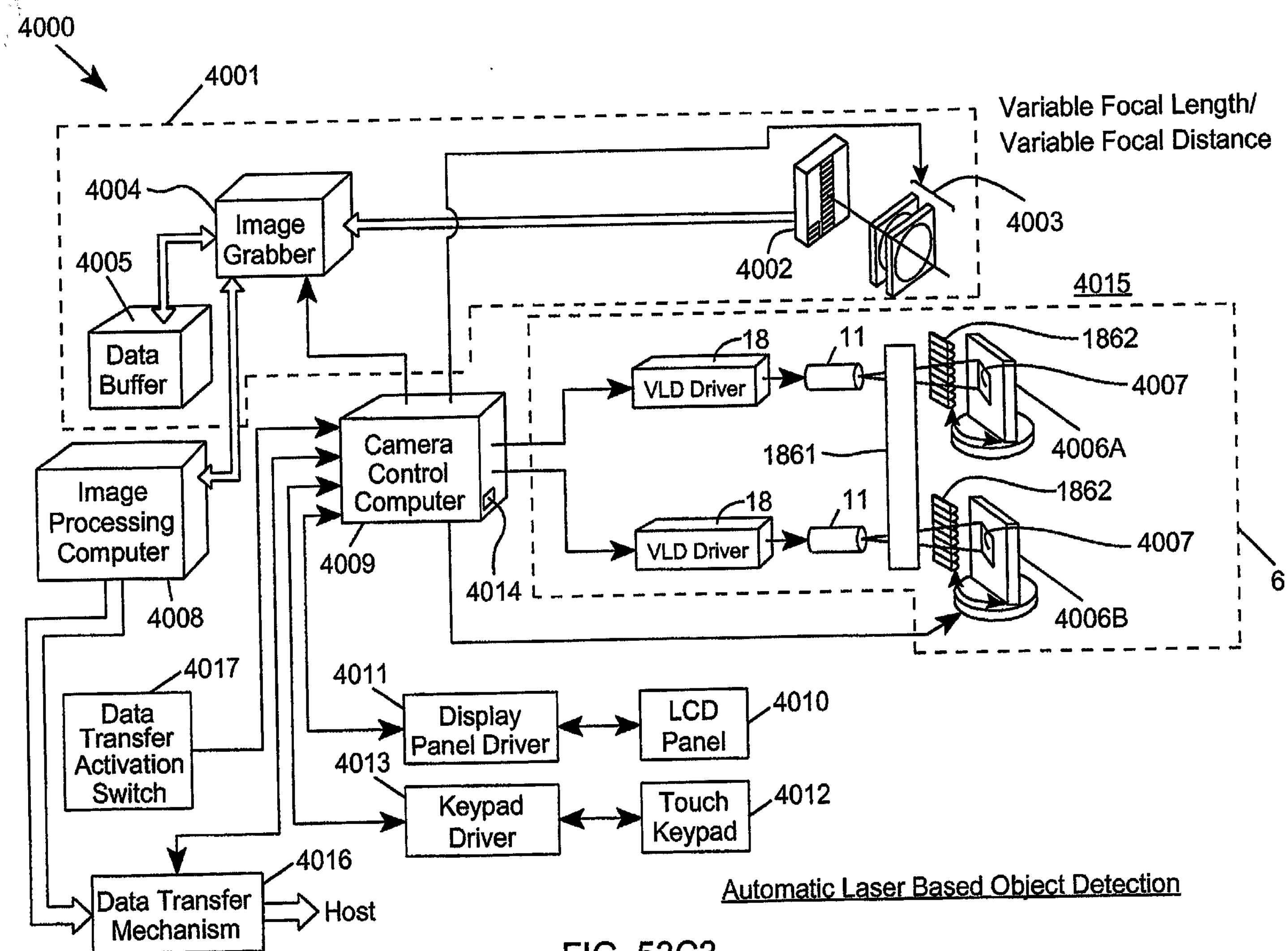

3080
3081
Variable Focal Length/
Variable Focal Distance
3084
Image Grabber
3085
Data Buffer
3082
3083
18
11
1862
VLD Driver
3087
1861
3086A
Image Processing Computer
Camera Control Computer
3089
3088
VLD Driver
3086B
6
3097
Data Transfer Activation Switch
3091
Display Panel Driver
LCD Panel
3090
3094
IR-Based Object Detection Subsystem
(3095)
3093
Keypad Driver
Touch Keypad
3092
IR Sensing Beam
3096
Data Transfer Mechanism
Host
Automatic IR Based Object Detection

FIG. 53C2



4000
4001
Variable Focal Length/
Variable Focal Distance
4003
4004
Image Grabber
4005
Data Buffer
4002
4015
18
11
1862
VLD Driver
4007
4006A
1861
Image Processing Computer
Camera Control Computer
18
11
1862
VLD Driver
4007
4009
4014
4006B
6
4008
4017
Data Transfer Activation Switch
4011
Display Panel Driver
LCD Panel
4010
4013
Keypad Driver
Touch Keypad
4012
4016
Data Transfer Mechanism
Host
Automatic Laser Based Object Detection

FIG. 53C3

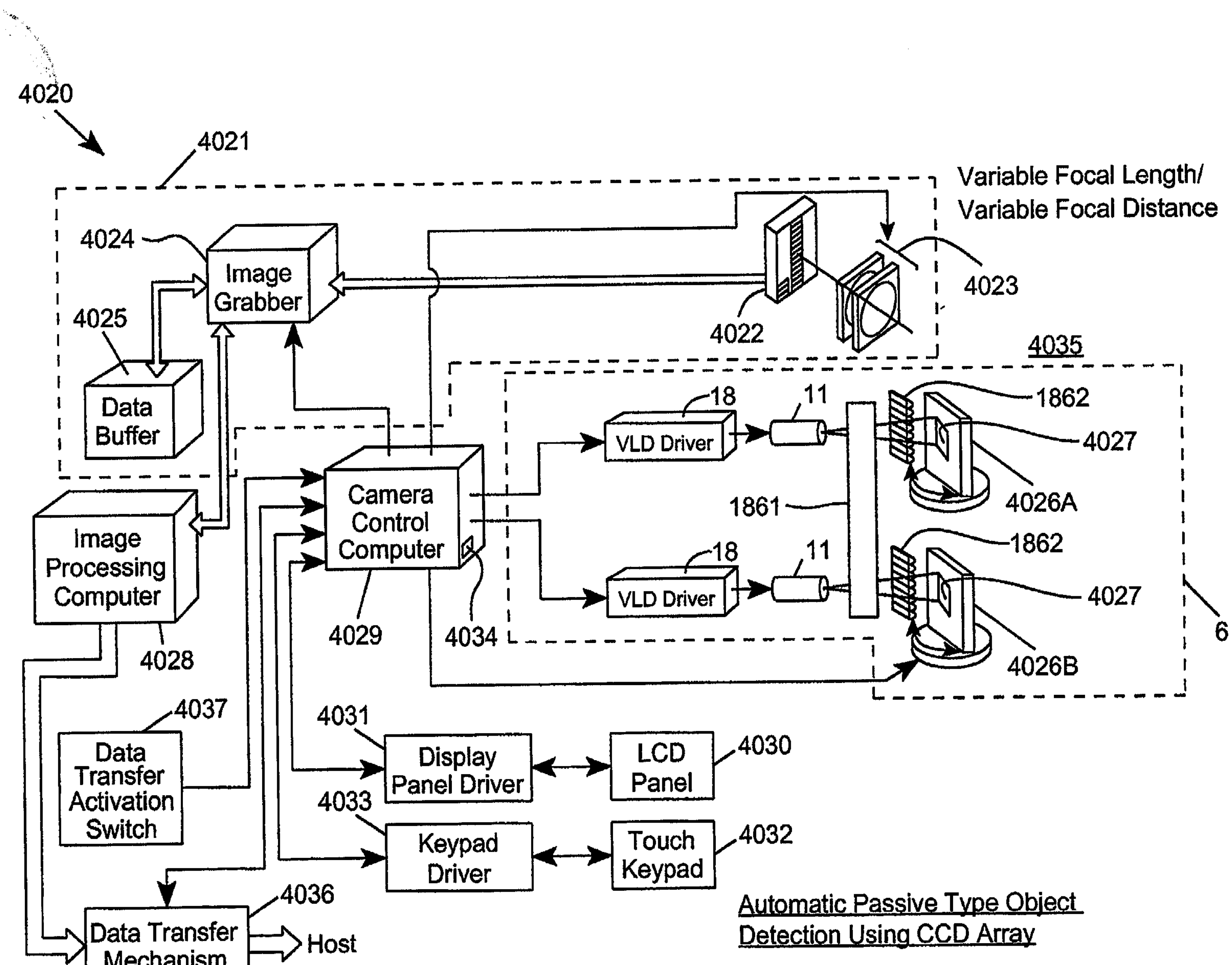

4020
4021
Variable Focal Length/
Variable Focal Distance
4023
4022
4024
Image
Grabber
4025
Data
Buffer
Image
Processing
Computer
4028
Camera
Control
Computer
4029
4034
4035
18
VLD Driver
11
1861
1862
4027
4026A
4026B
6
4037
Data
Transfer
Activation
Switch
4031
Display
Panel Driver
LCD
Panel
4030
4033
Keypad
Driver
Touch
Keypad
4032
4036
Data Transfer
Mechanism
Host
Automatic Passive Type Object
Detection Using CCD Array

FIG. 53C4

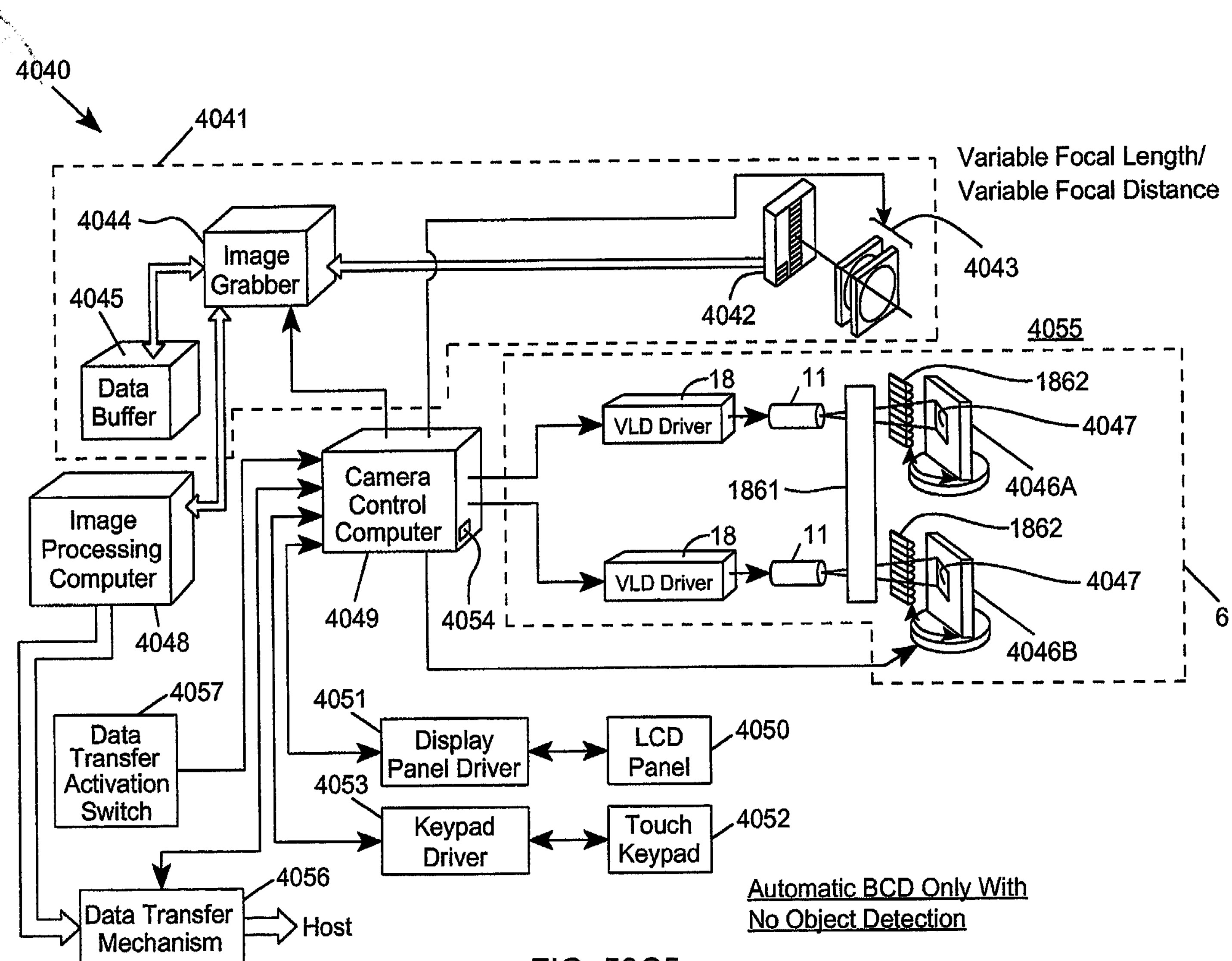

4040
4041
Variable Focal Length/
Variable Focal Distance
4044
Image Grabber
4045
Data Buffer
4042
4043
4055
18
11
VLD Driver
1862
4047
4046A
1861
1862
4047
4046B
6
Image Processing Computer
4048
Camera Control Computer
4049
4054
4057
Data Transfer Activation Switch
4051
Display Panel Driver
LCD Panel
4050
4053
Keypad Driver
Touch Keypad
4052
4056
Data Transfer Mechanism
Host
Automatic BCD Only With
No Object Detection

FIG. 53C5

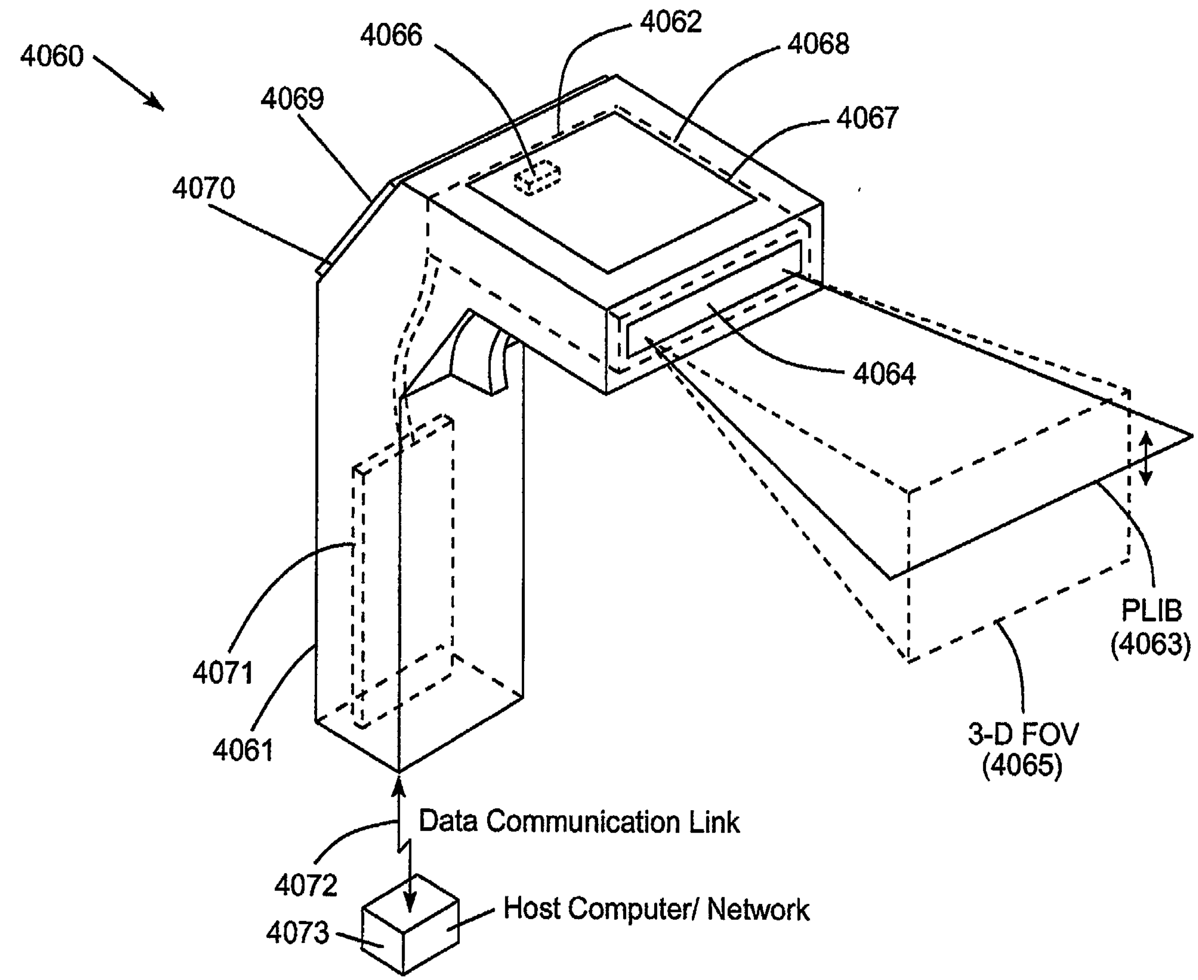
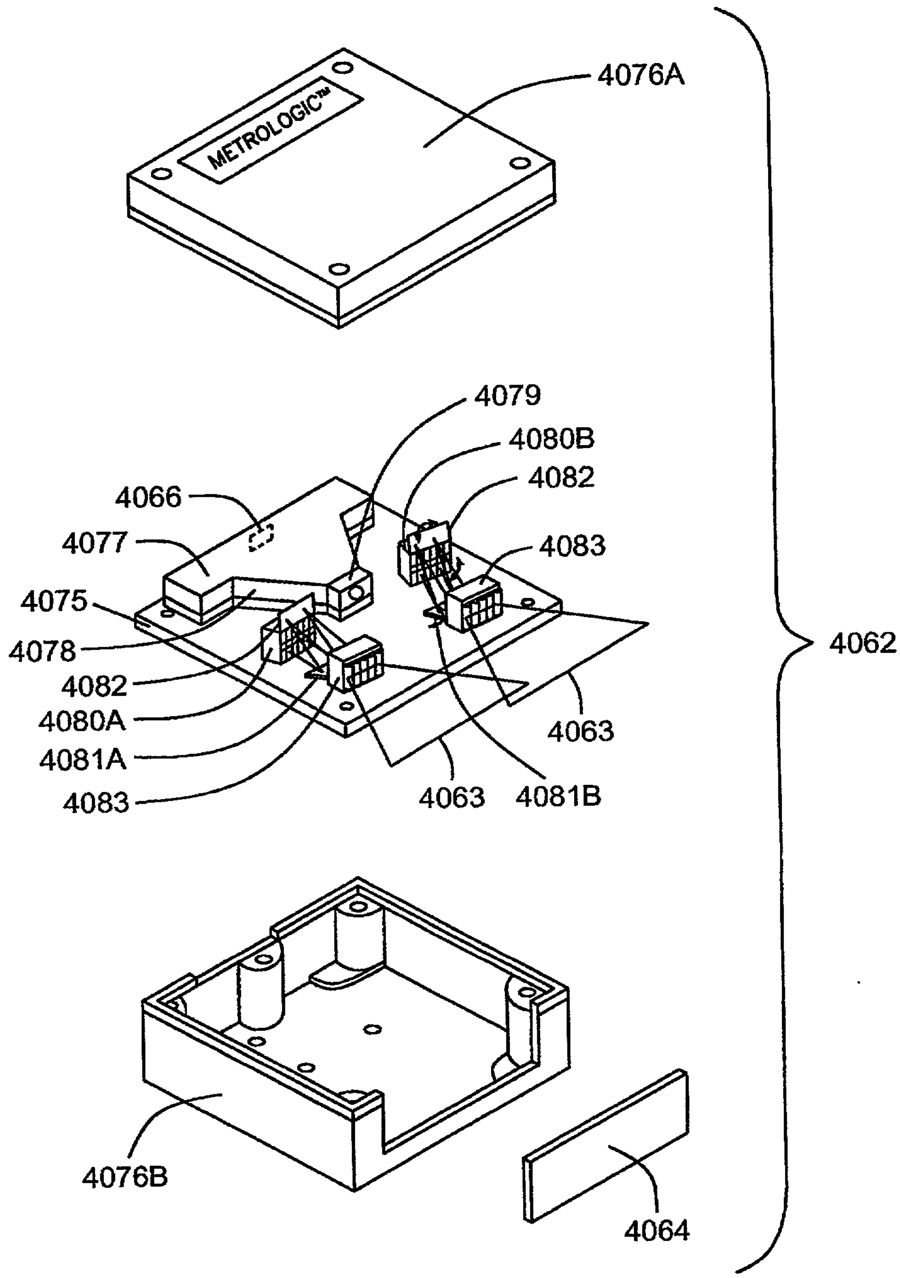

4060
4066
4062
4068
4069
4067
4070
4064
4071
4061
PLIB
(4063)
3-D FOV
(4065)
Data Communication Link
4072
4073
Host Computer/ Network

FIG. 54A



(Dual Mirrors)
Fig. 1I5A-5D

FIG. 54B

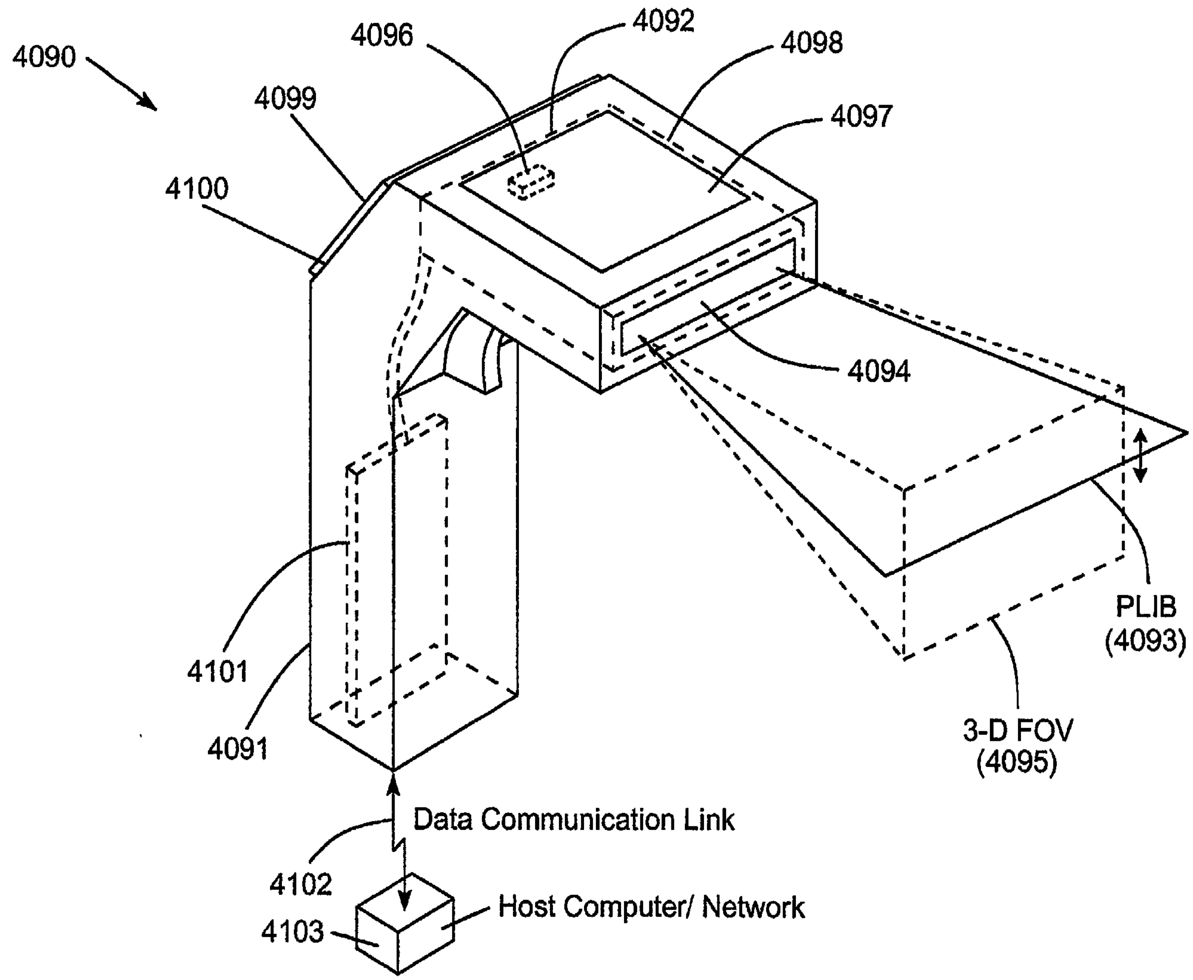
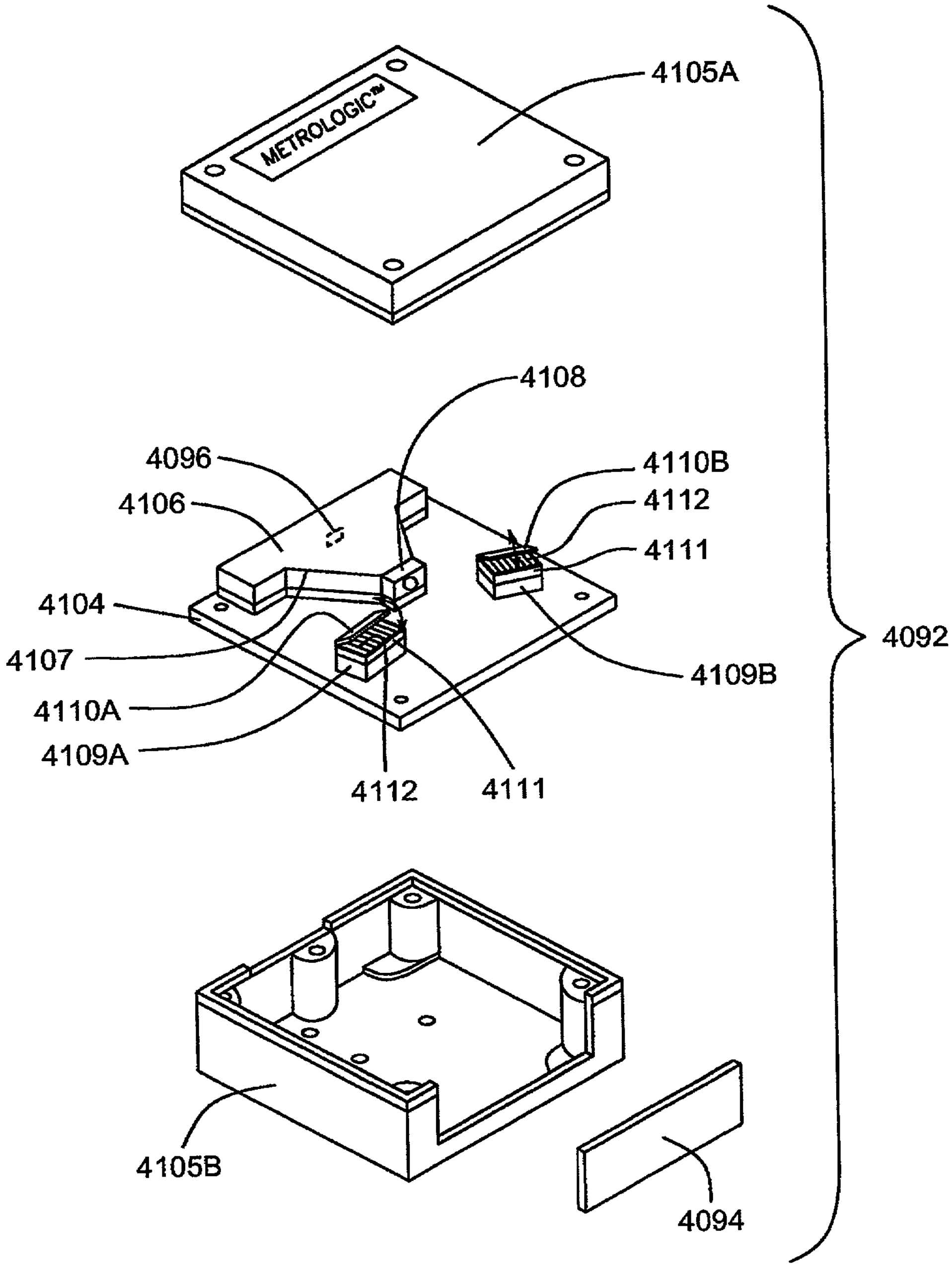

4090
4099
4100
4096
4092
4098
4097
4094
4101
4091
PLIB
(4093)
3-D FOV
(4095)
Data Communication Link
4102
4103
Host Computer/ Network

FIG. 55A



Bragg Cell
Fig. 1I6A-6B

FIG. 55B

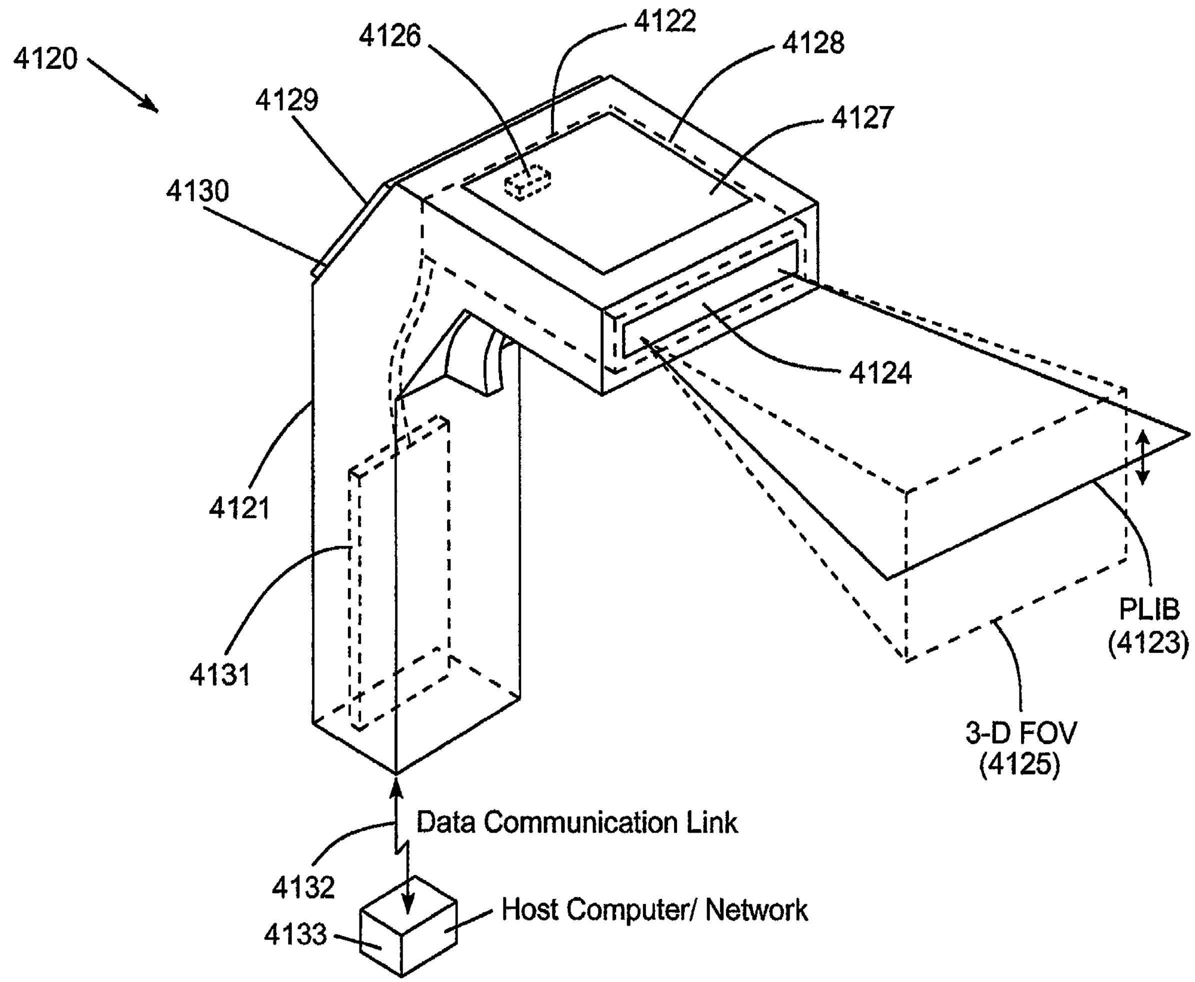
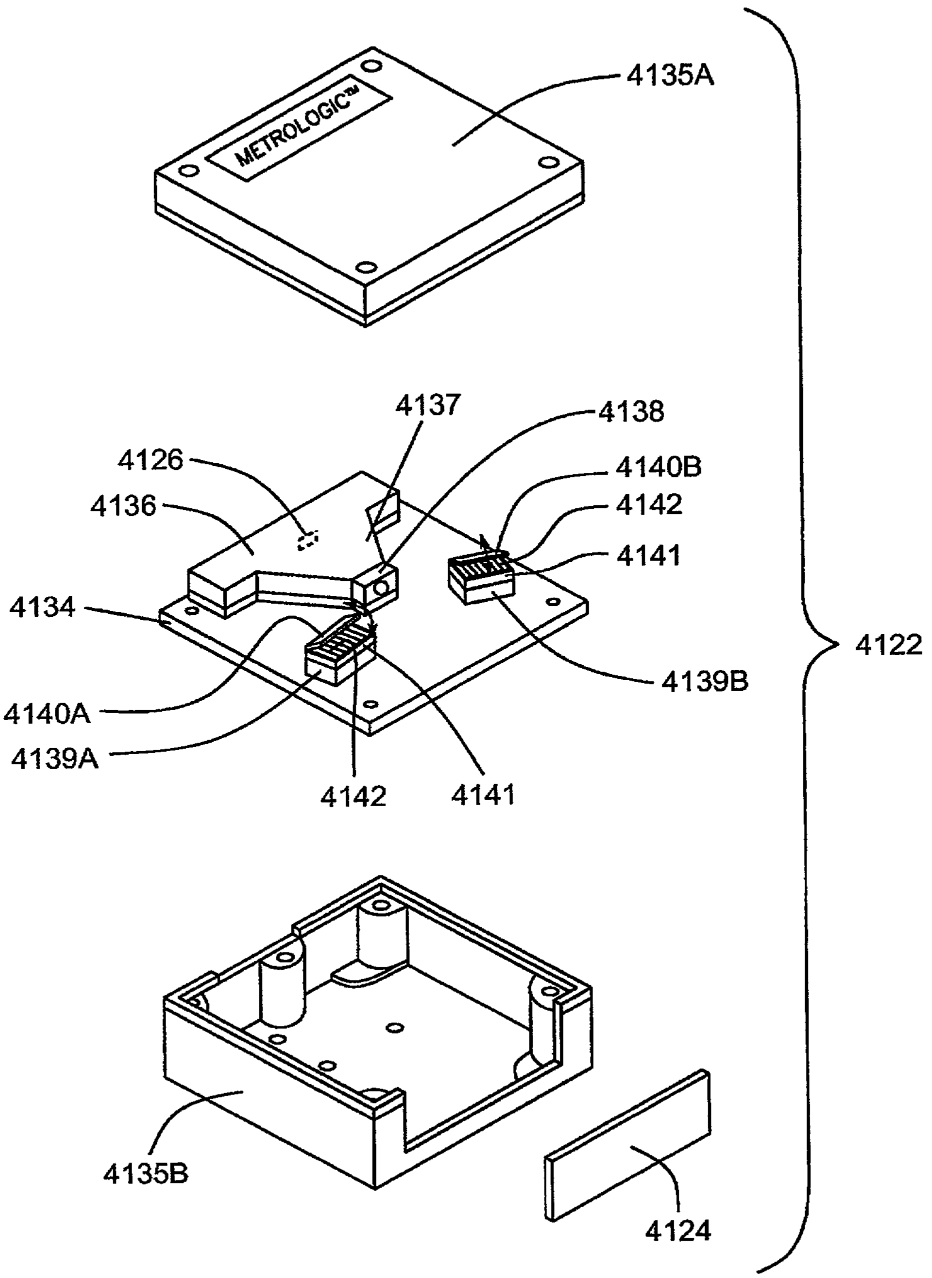

4120
4126
4122
4128
4127
4129
4130
4121
4131
4124
PLIB
(4123)
3-D FOV
(4125)
Data Communication Link
4132
4133
Host Computer/ Network

FIG. 56A



DM
Fig. 1I7A-7B

FIG. 56B

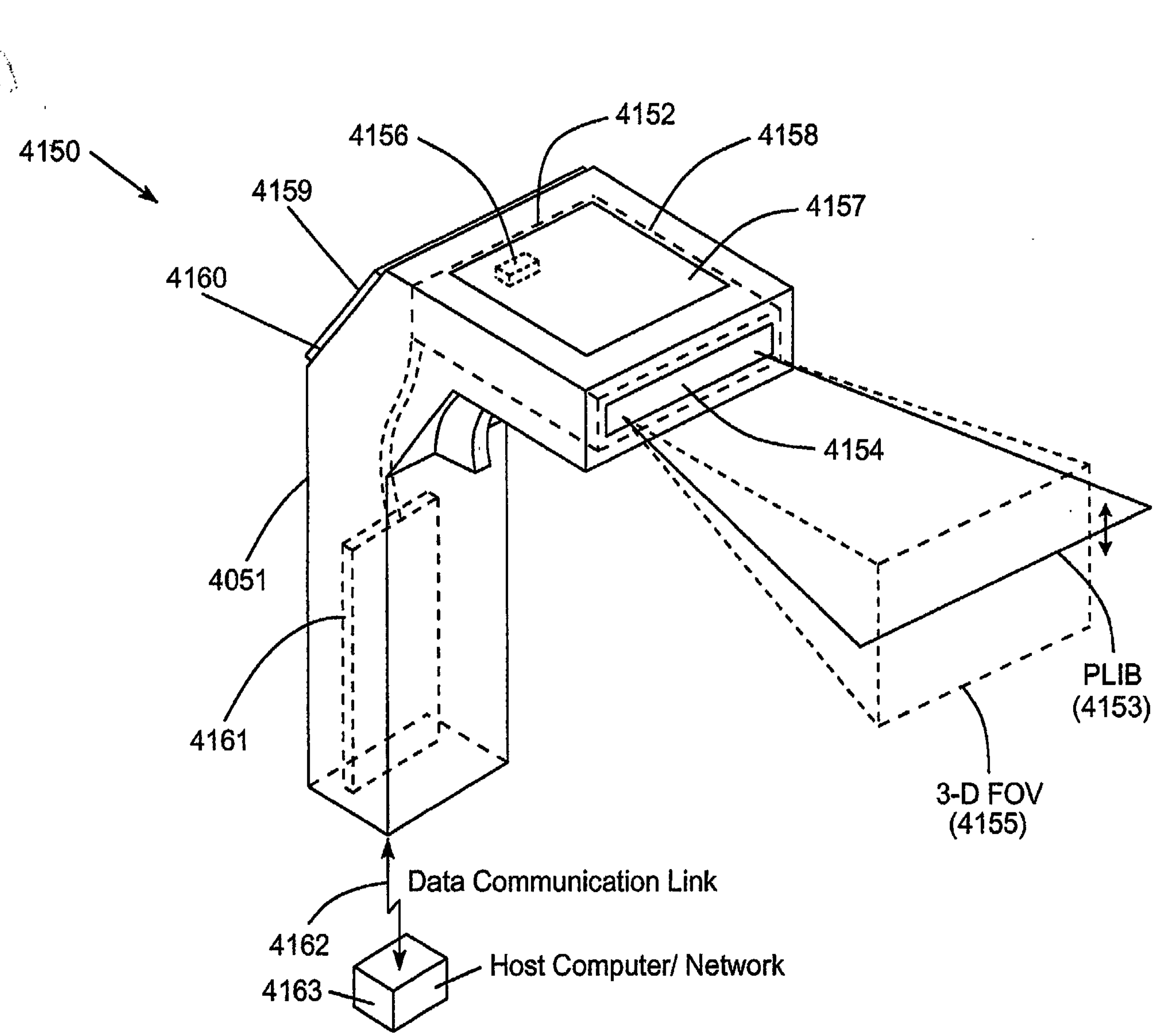

4150
4156
4152
4158
4157
4159
4160
4154
4051
4161
PLIB
(4153)
3-D FOV
(4155)
Data Communication Link
4162
4163
Host Computer/ Network

FIG. 57A

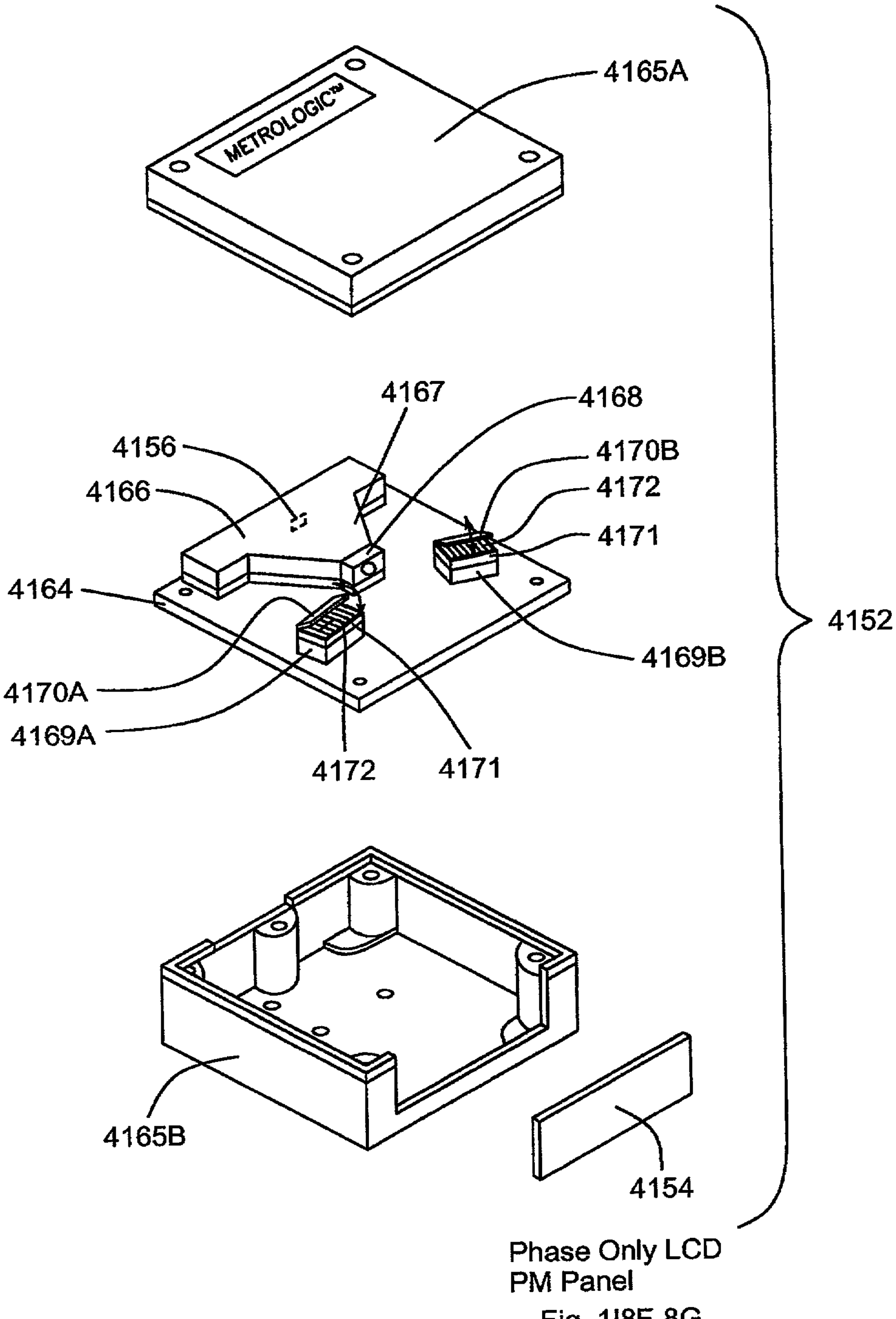

4165A
METROLOGIC™
4167
4168
4156
4170B
4166
4172
4171
4164
4152
4169B
4170A
4169A
4172
4171
4165B
4154
Phase Only LCD
PM Panel
Fig. 1I8F-8G

FIG. 57B

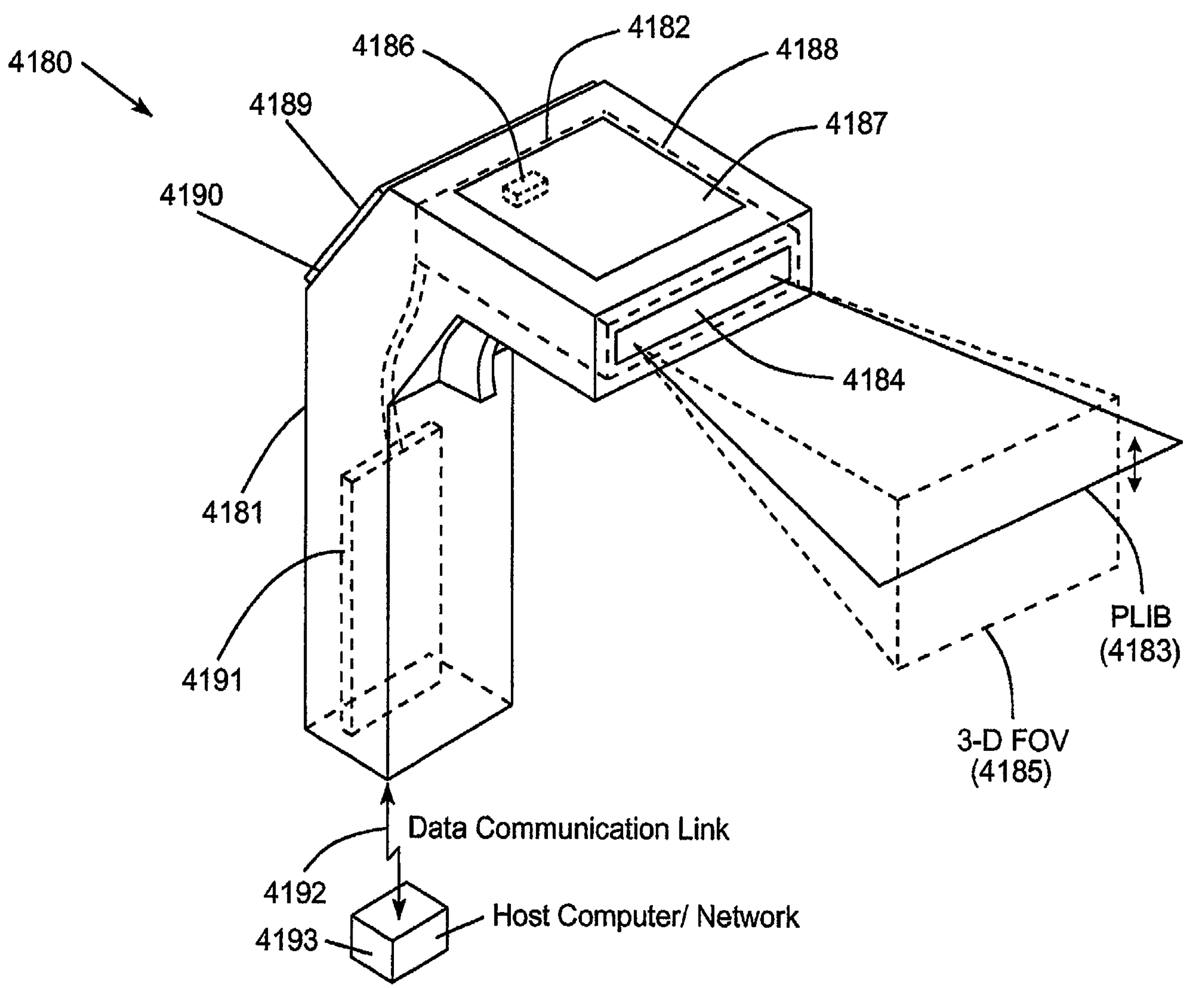
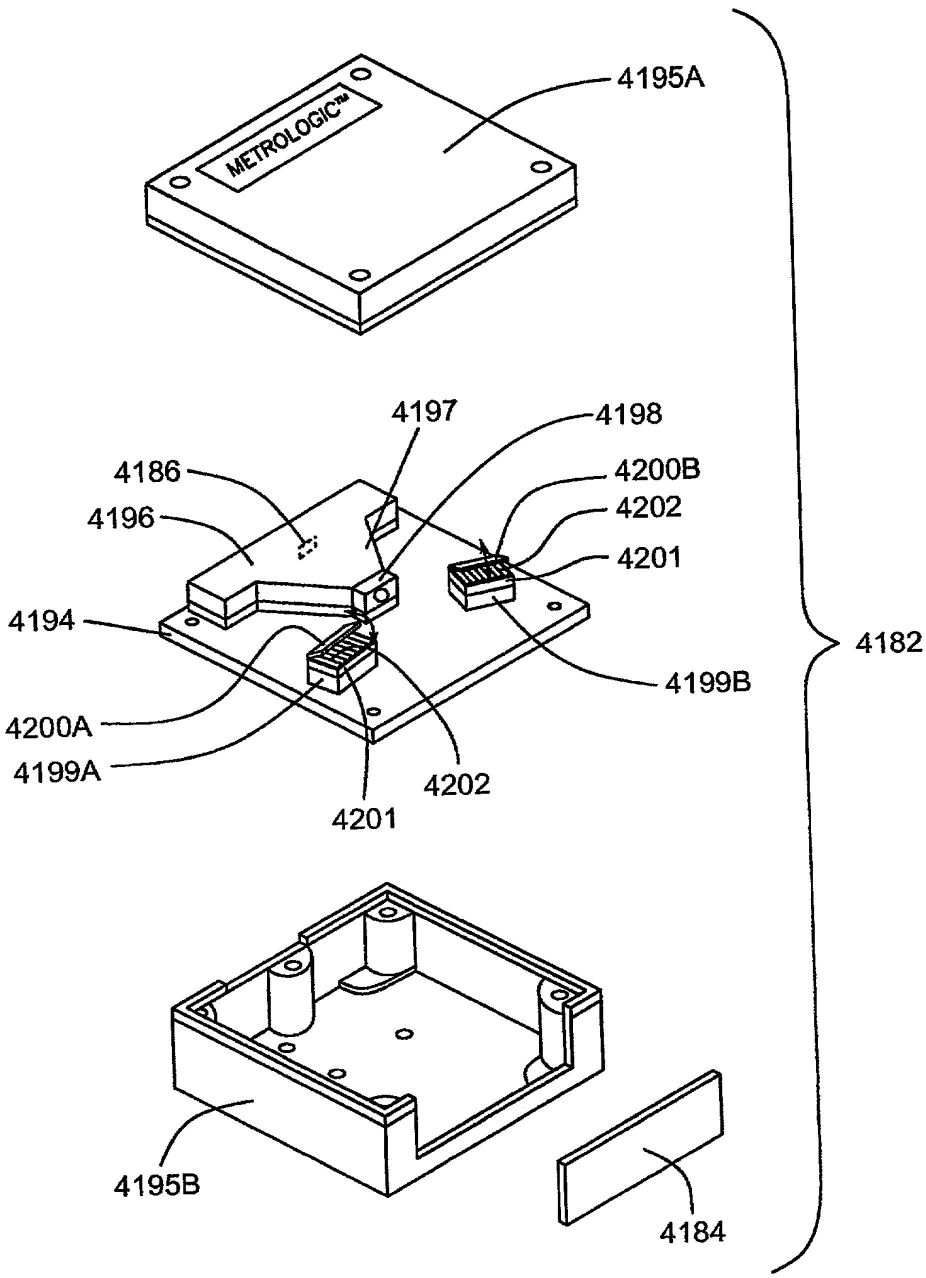

4180
4186
4182
4188
4187
4189
4190
4184
4181
4191
PLIB
(4183)
3-D FOV
(4185)
Data Communication Link
4192
4193
Host Computer/ Network

FIG. 58A



HS Optical Shutter
Fig. 1I14A-14B

FIG. 58B

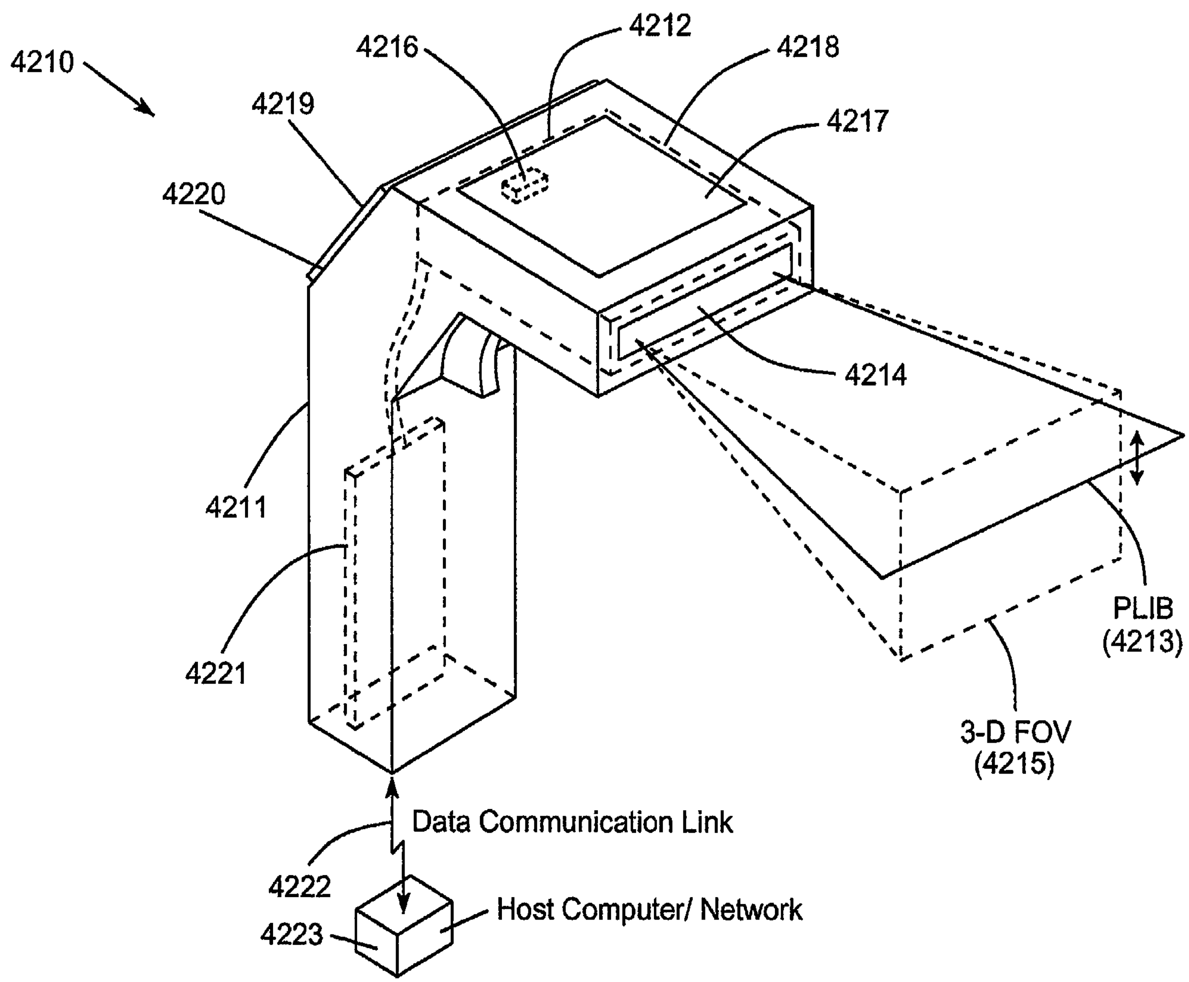
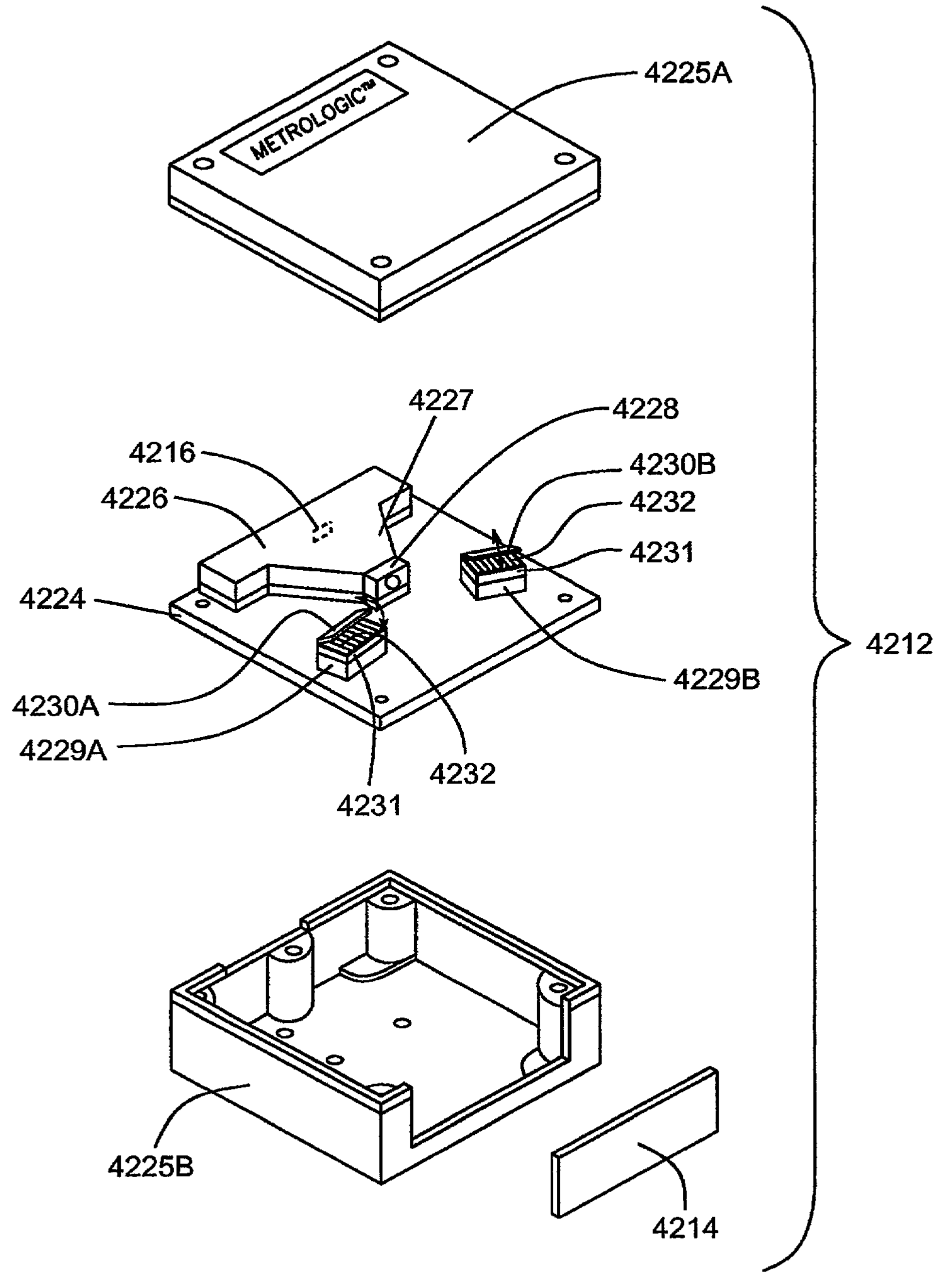

4210
4216
4212
4218
4217
4219
4220
4214
4211
4221
PLIB
(4213)
3-D FOV
(4215)
Data Communication Link
4222
4223
Host Computer/ Network

FIG. 59A



MLLD

Fig. 1I15A-15B

FIG. 59B

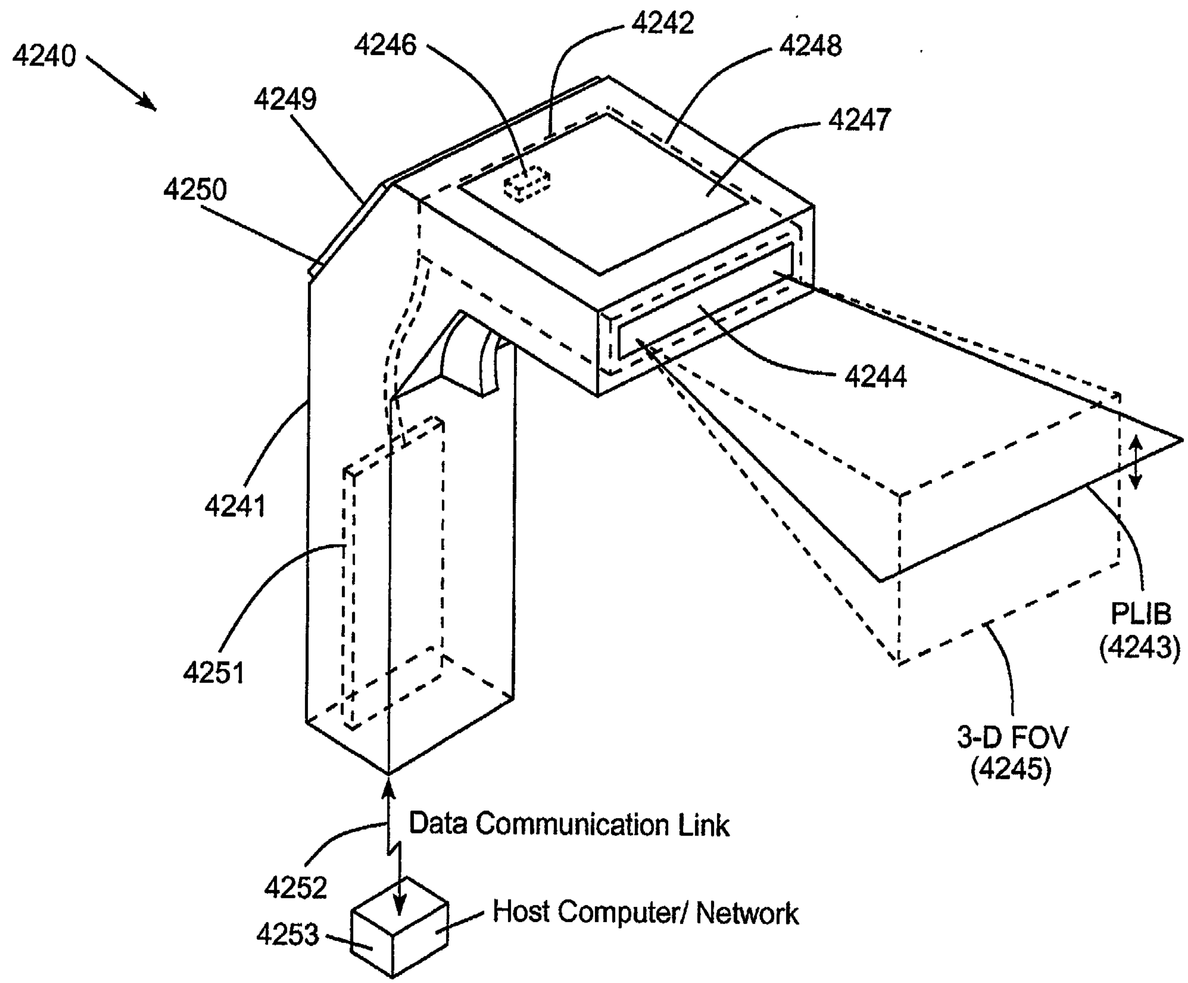
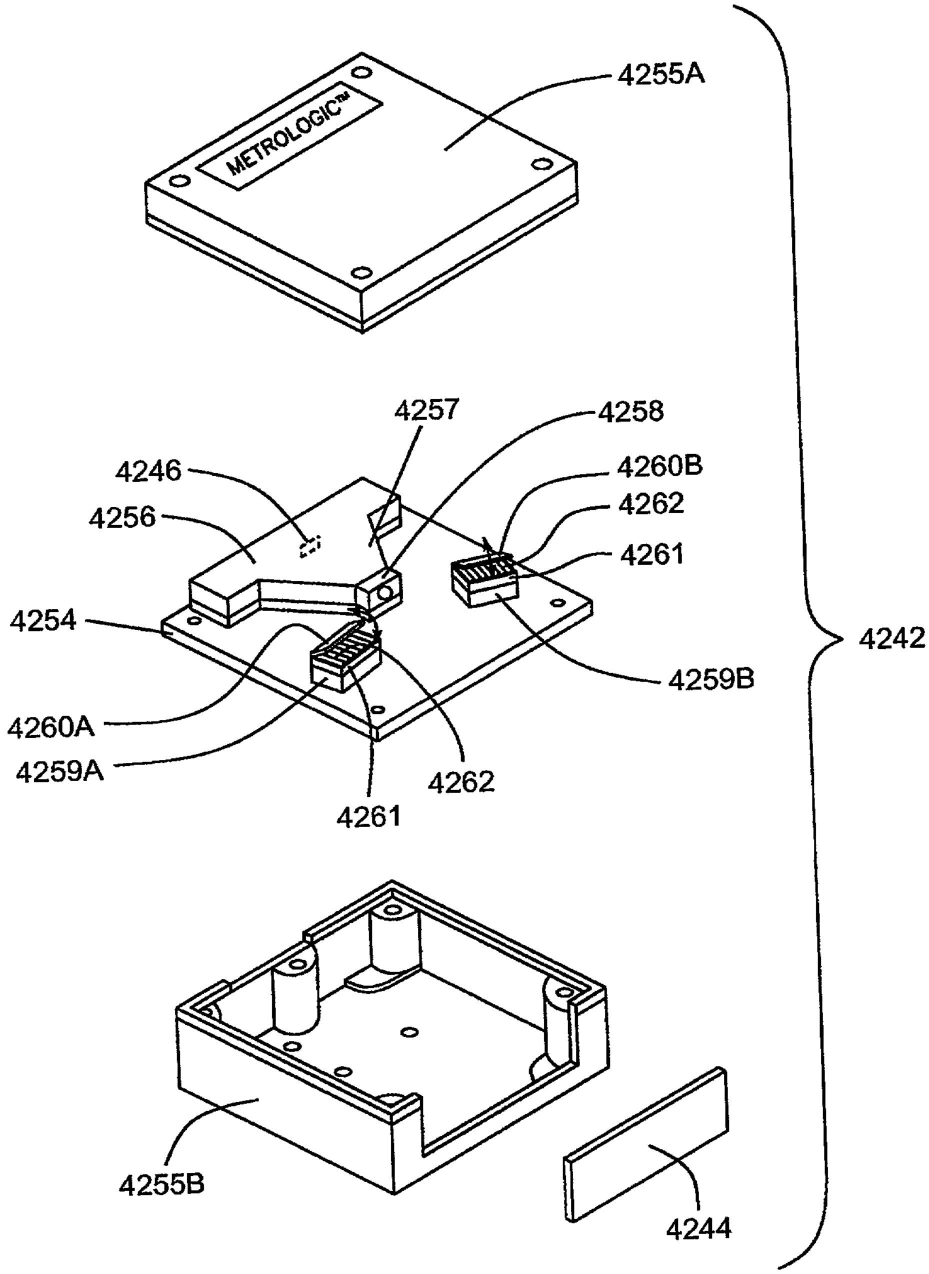

4240
4246
4242
4248
4249
4247
4250
4244
4241
4251
PLIB
(4243)
3-D FOV
(4245)
Data Communication Link
4252
4253
Host Computer/ Network

FIG. 60A



Etalon (Temp. Phase Mod.)
Fig. 1I17A-17B

FIG. 60B

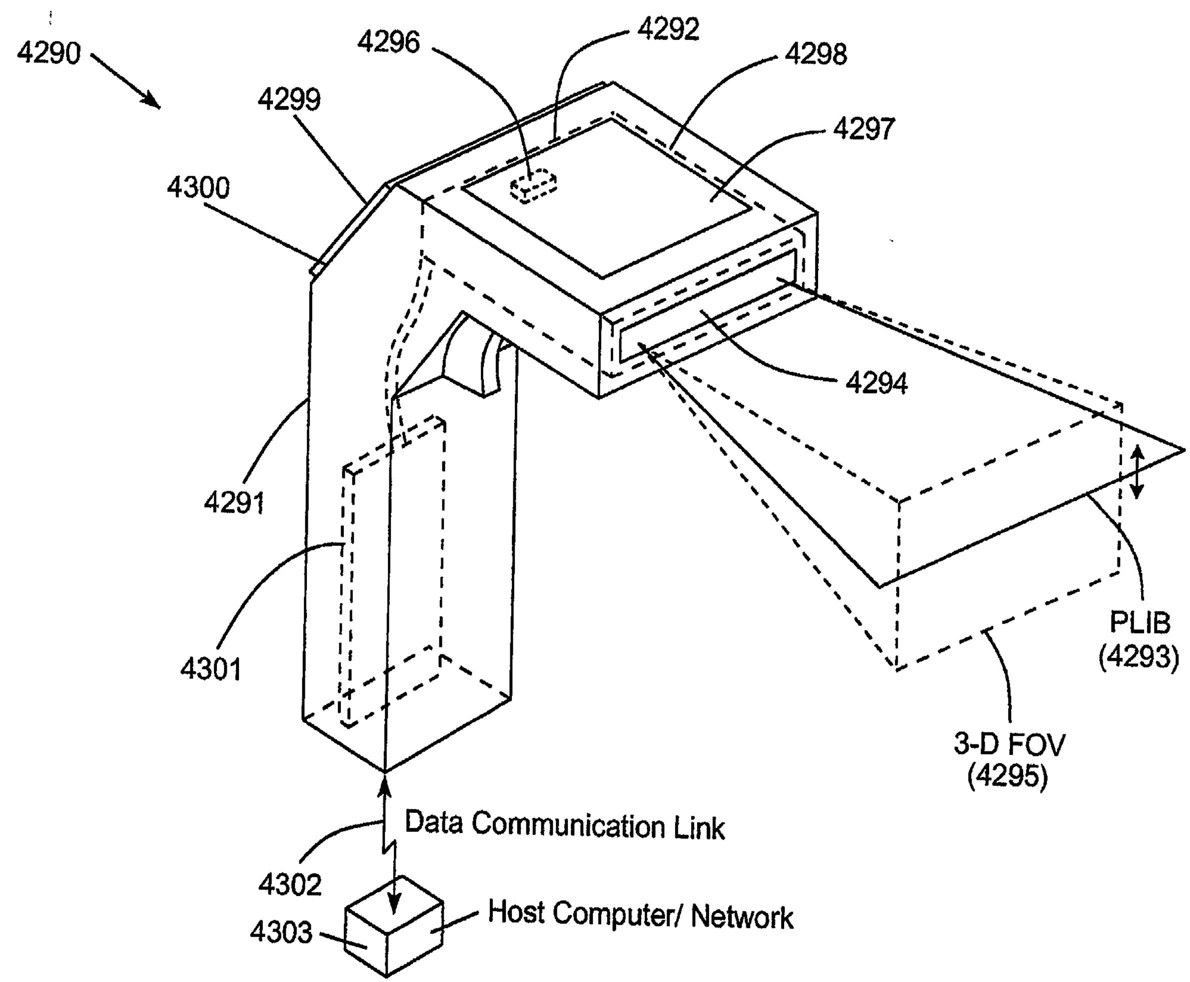
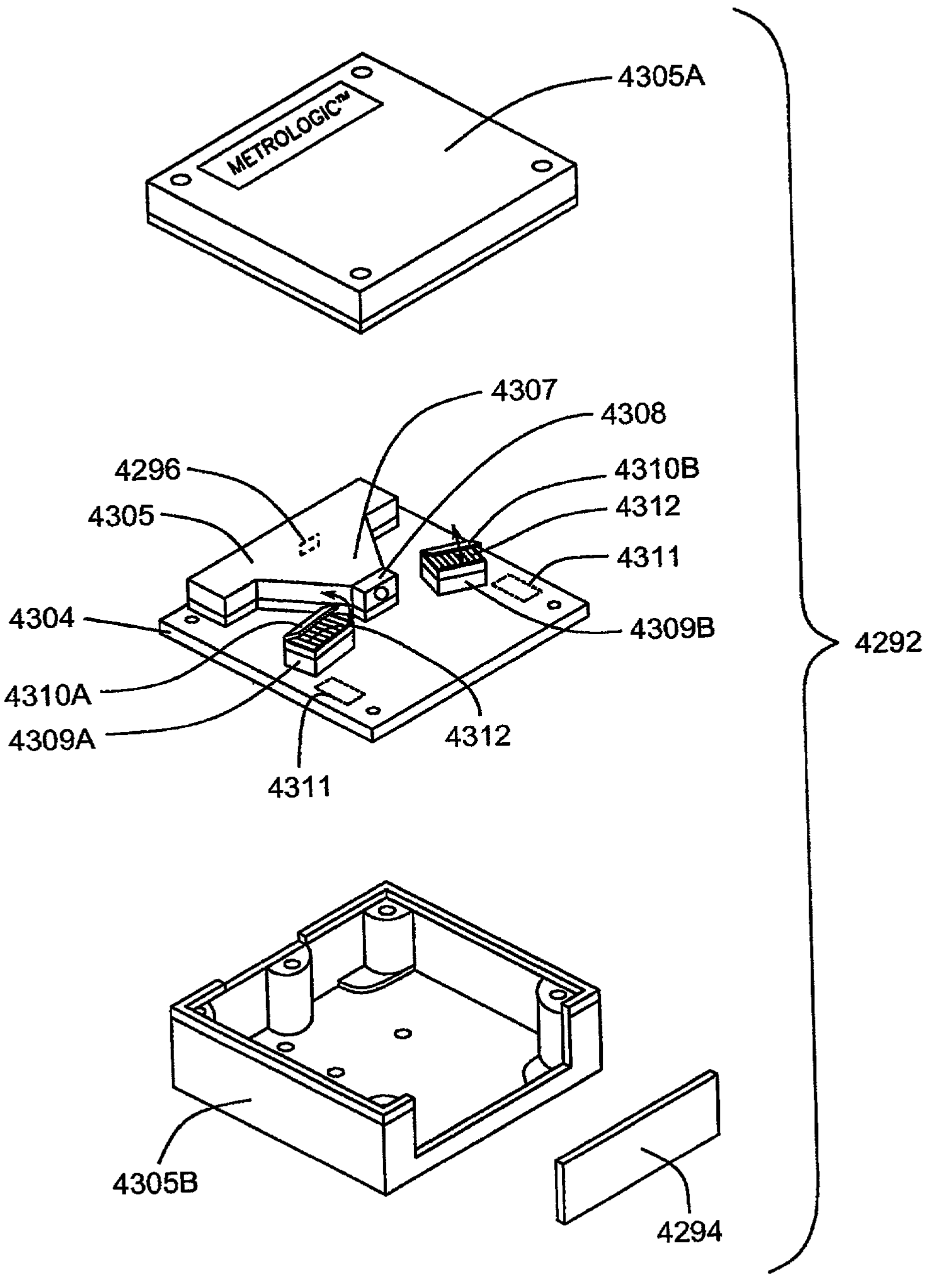

4290
4296
4292
4298
4299
4297
4300
4294
4291
4301
PLIB
(4293)
3-D FOV
(4295)
Data Communication Link
4302
4303
Host Computer/ Network

FIG. 61A



Mode Hopping
Fig. 1I19A-19B

FIG. 61B

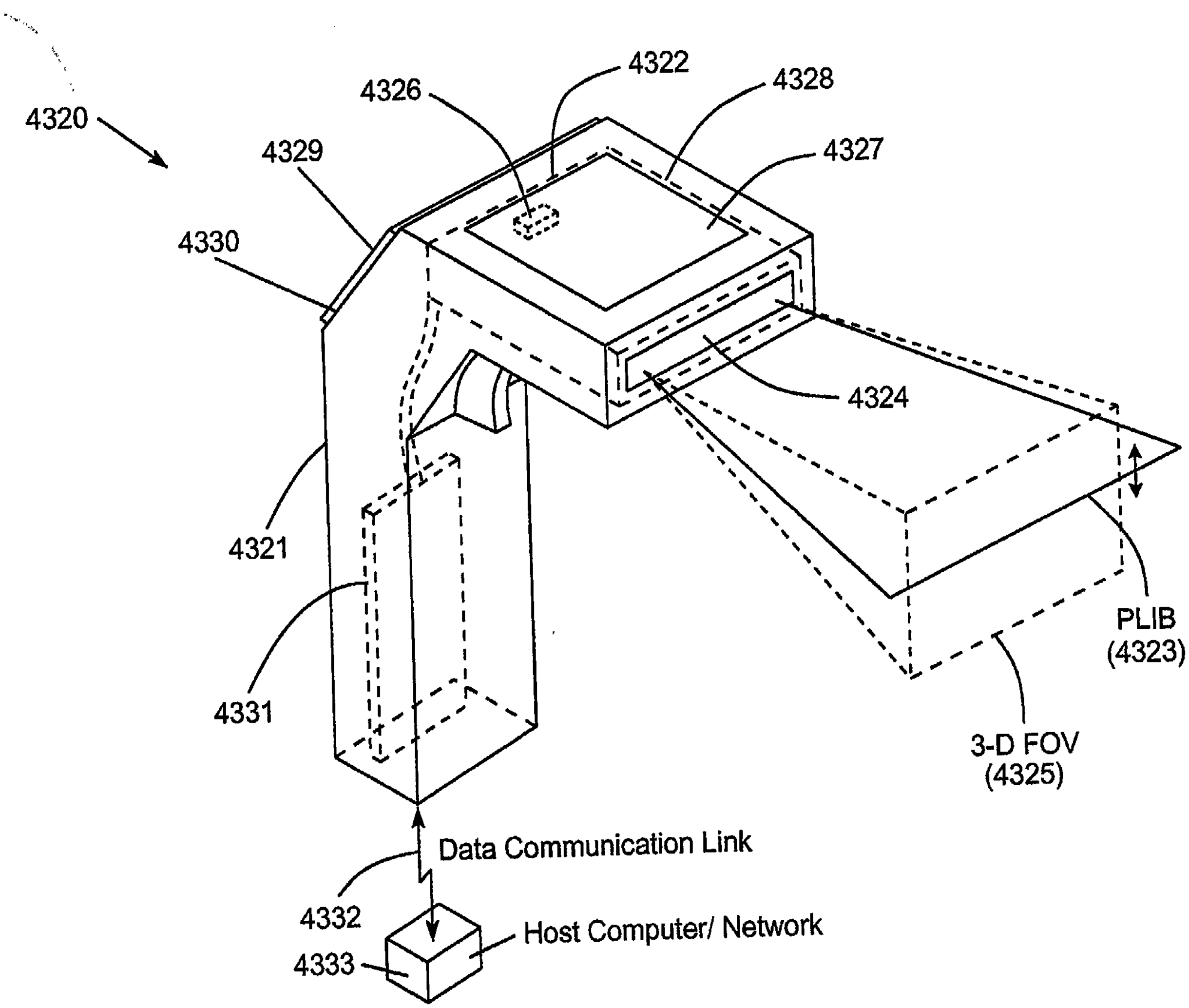
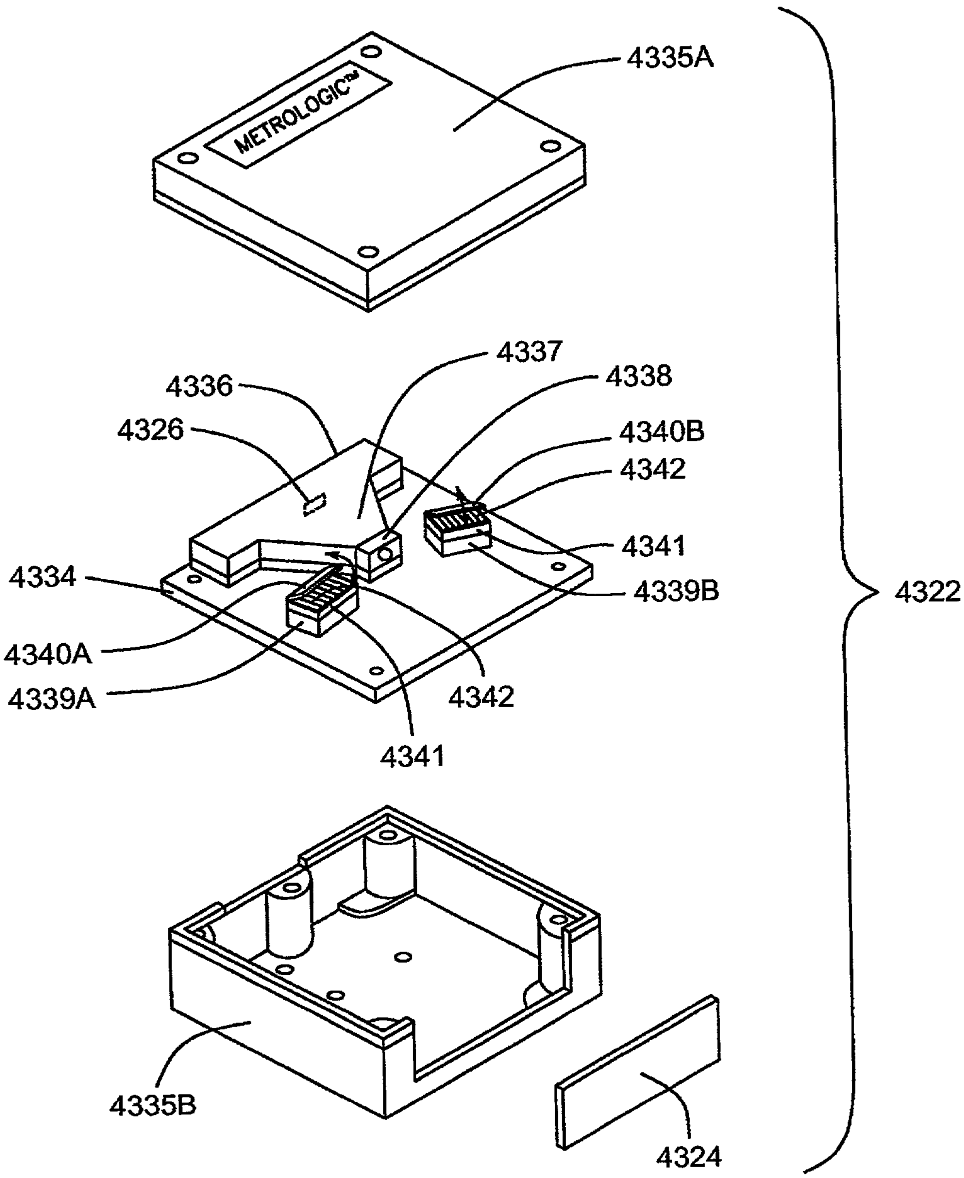

4320
4329
4330
4326
4322
4328
4327
4324
4321
4331
PLIB
(4323)
3-D FOV
(4325)
Data Communication Link
4332
4333
Host Computer/ Network

FIG. 62A



Micro-oscillating
Spatial Intensity
Modulation Panels
Fig. 1I21A-21D

FIG. 62B

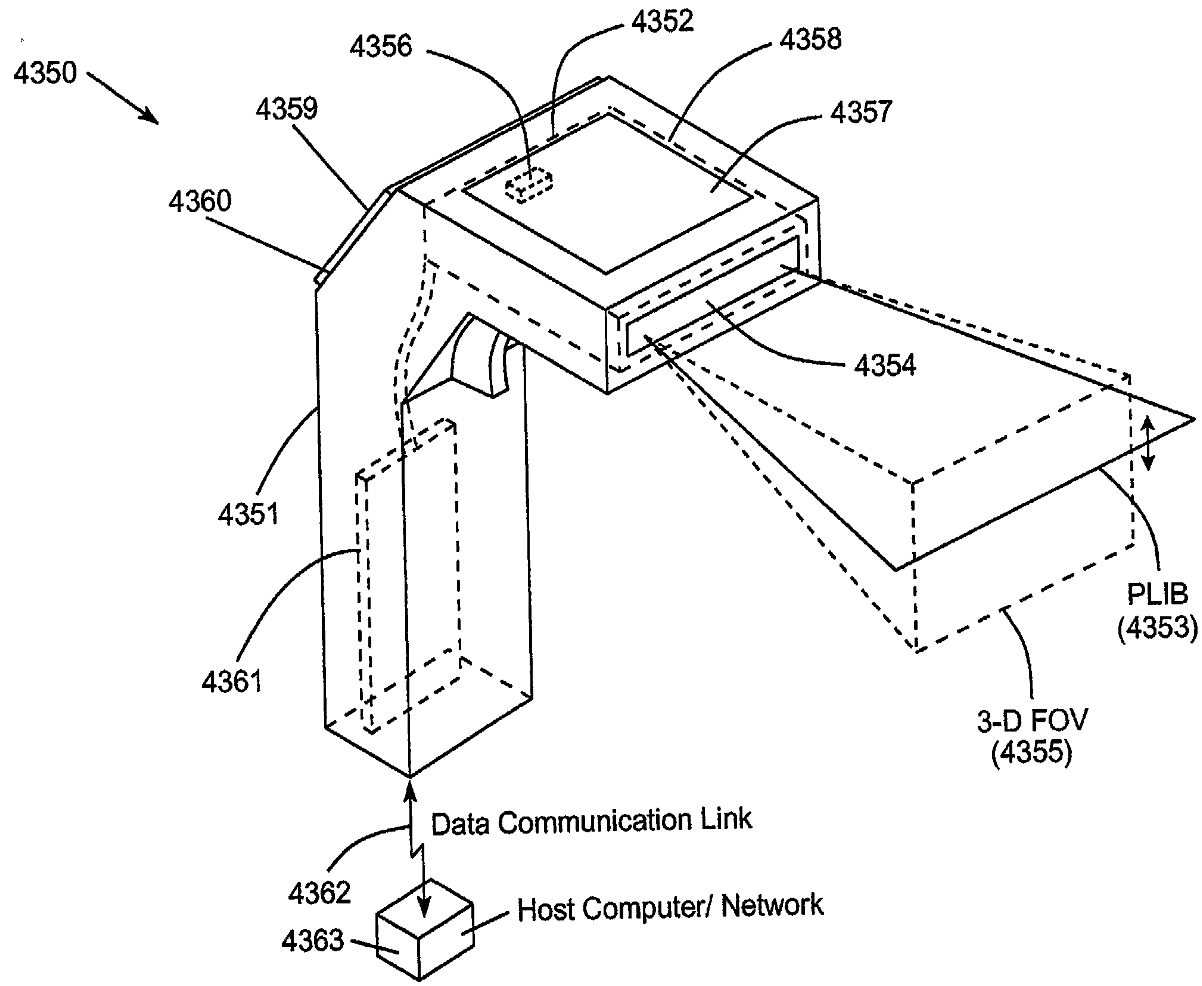
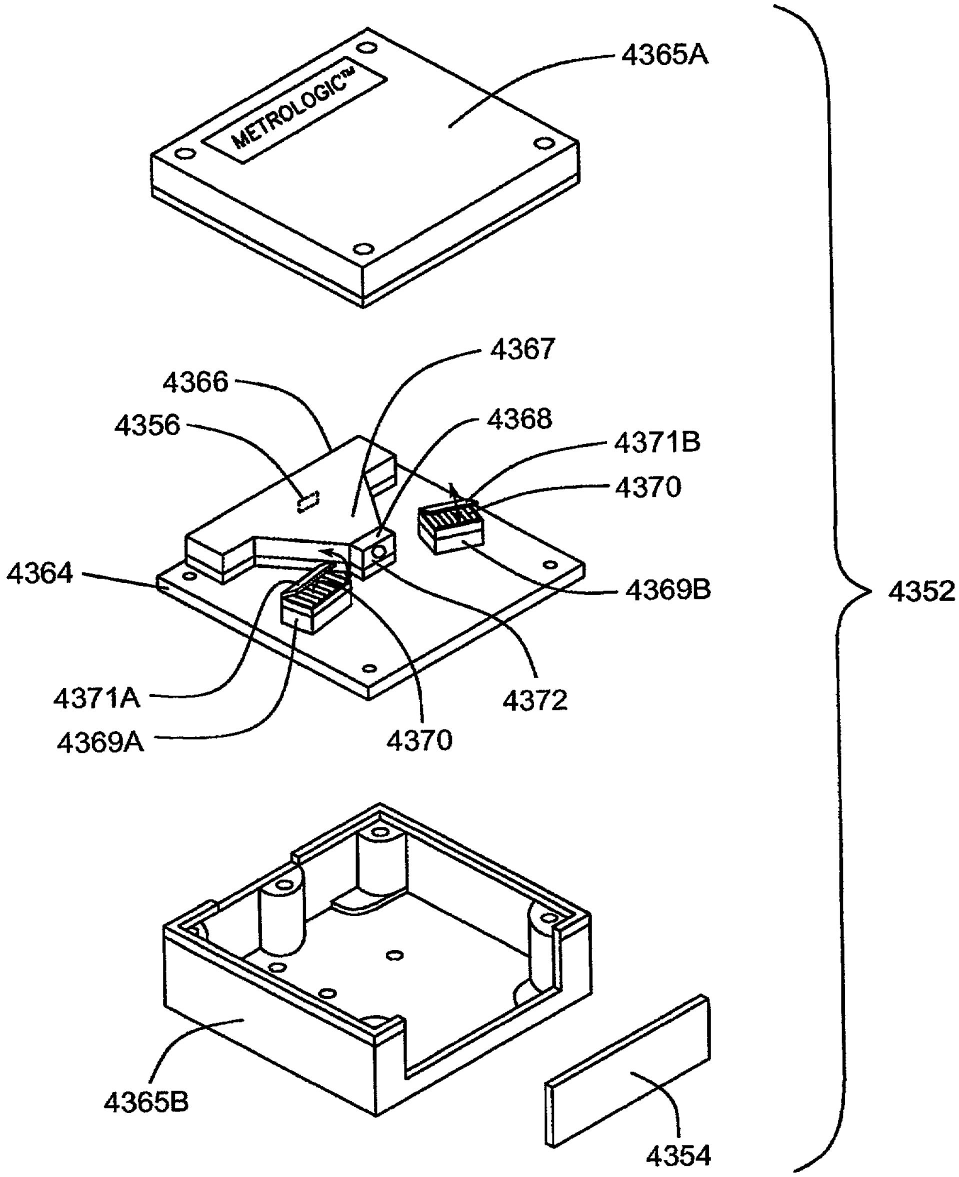

4350
4356
4352
4358
4357
4359
4360
4354
4351
4361
PLIB
(4353)
3-D FOV
(4355)
Data Communication Link
4362
4363
Host Computer/ Network

FIG. 63A



EO or Mechanically
Rotating Iris

Fig. 1I23A-23B

FIG. 63B

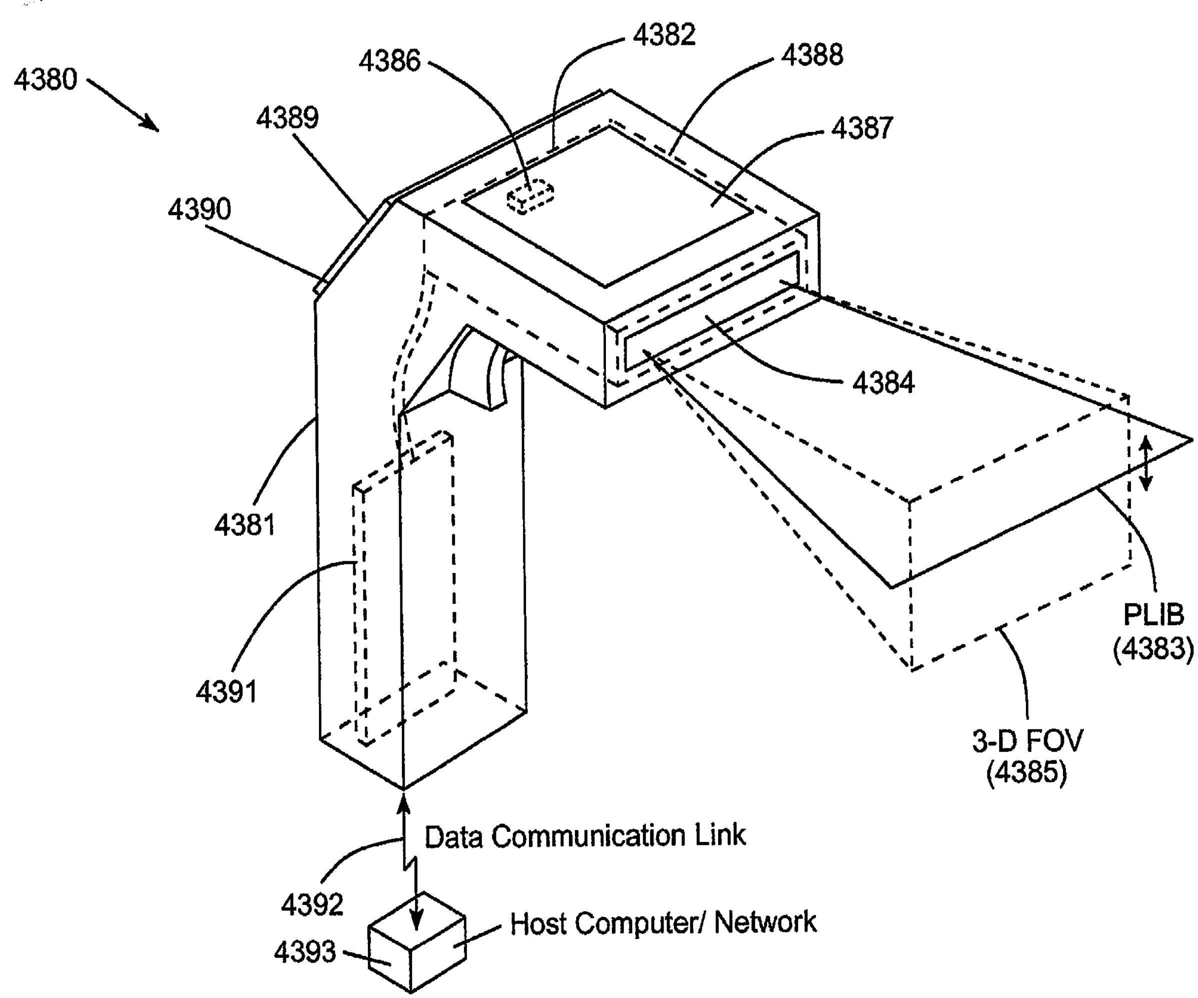
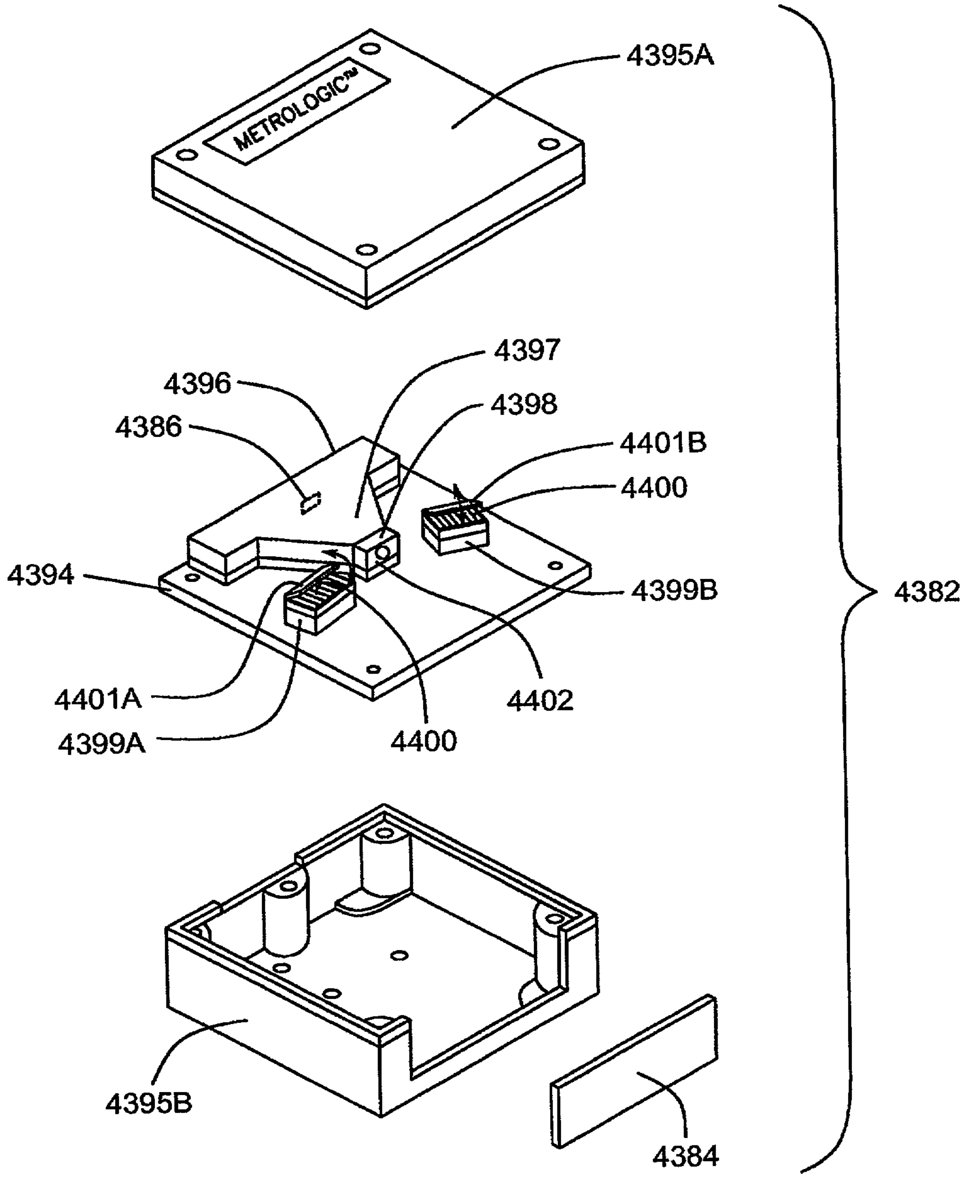

4380
4386
4382
4388
4387
4389
4390
4384
4381
4391
PLIB
(4383)
3-D FOV
(4385)
Data Communication Link
4392
4393
Host Computer/ Network

FIG. 64A

277/362



E-optical Shutter
Before IFD Lens

Fig. 1I24A

FIG. 64B

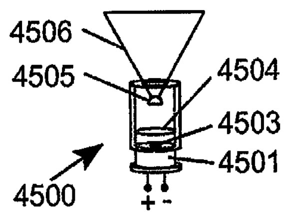


FIG. 65A

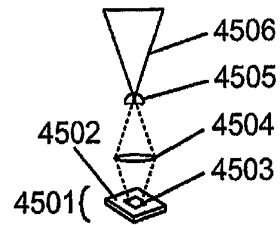


FIG. 65B

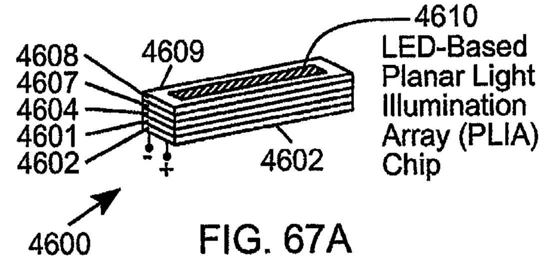


FIG. 67A

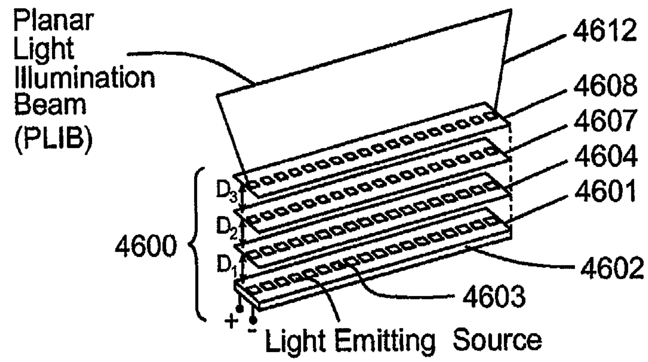


FIG. 67B

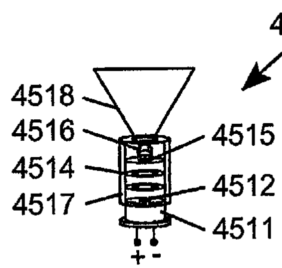


FIG. 66A

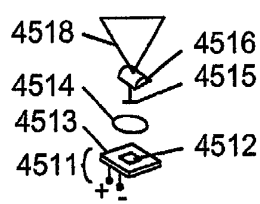


FIG. 66B

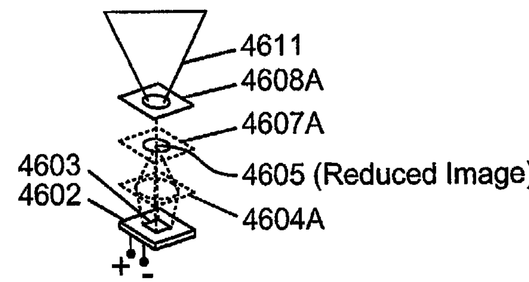


FIG. 67C

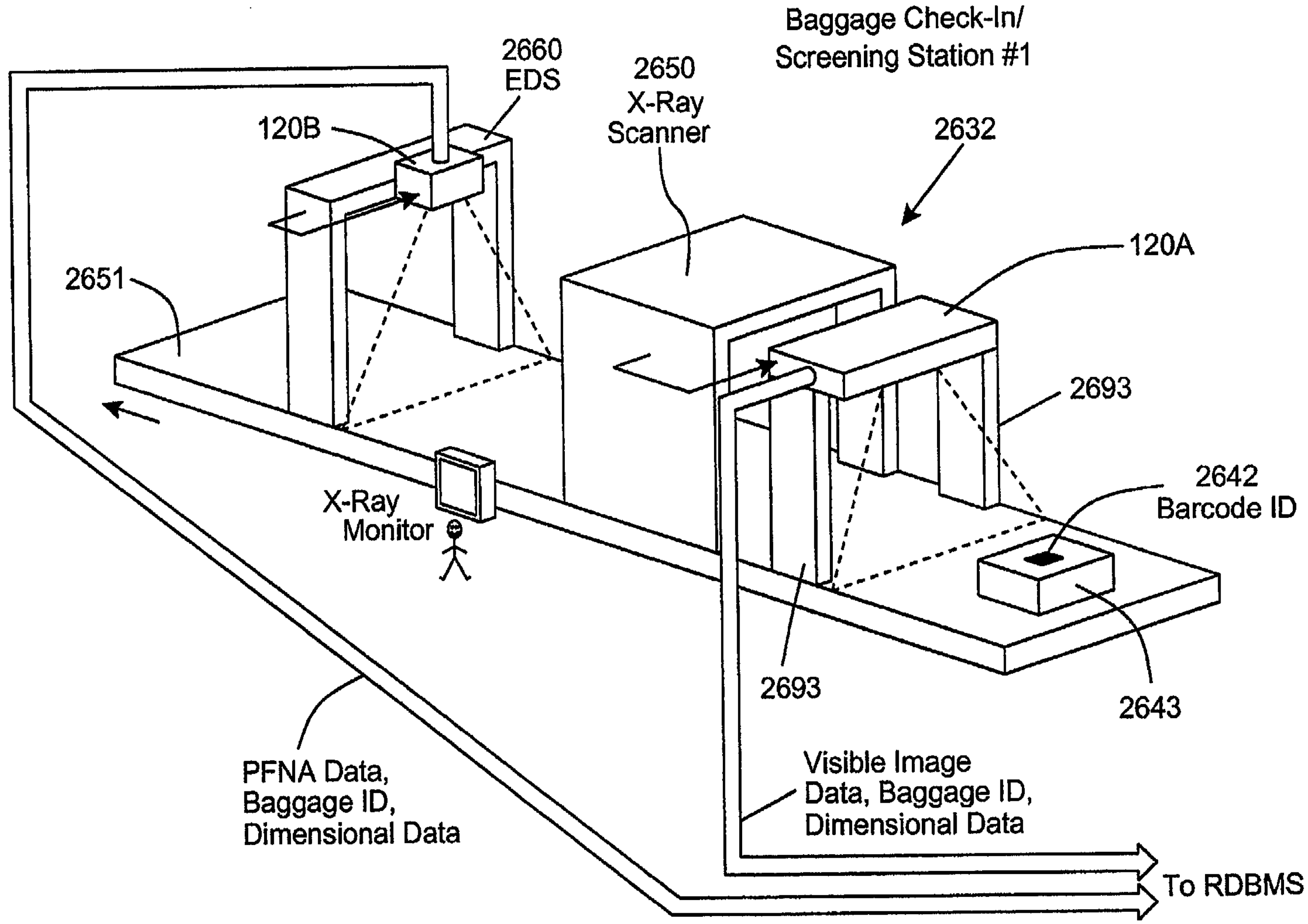
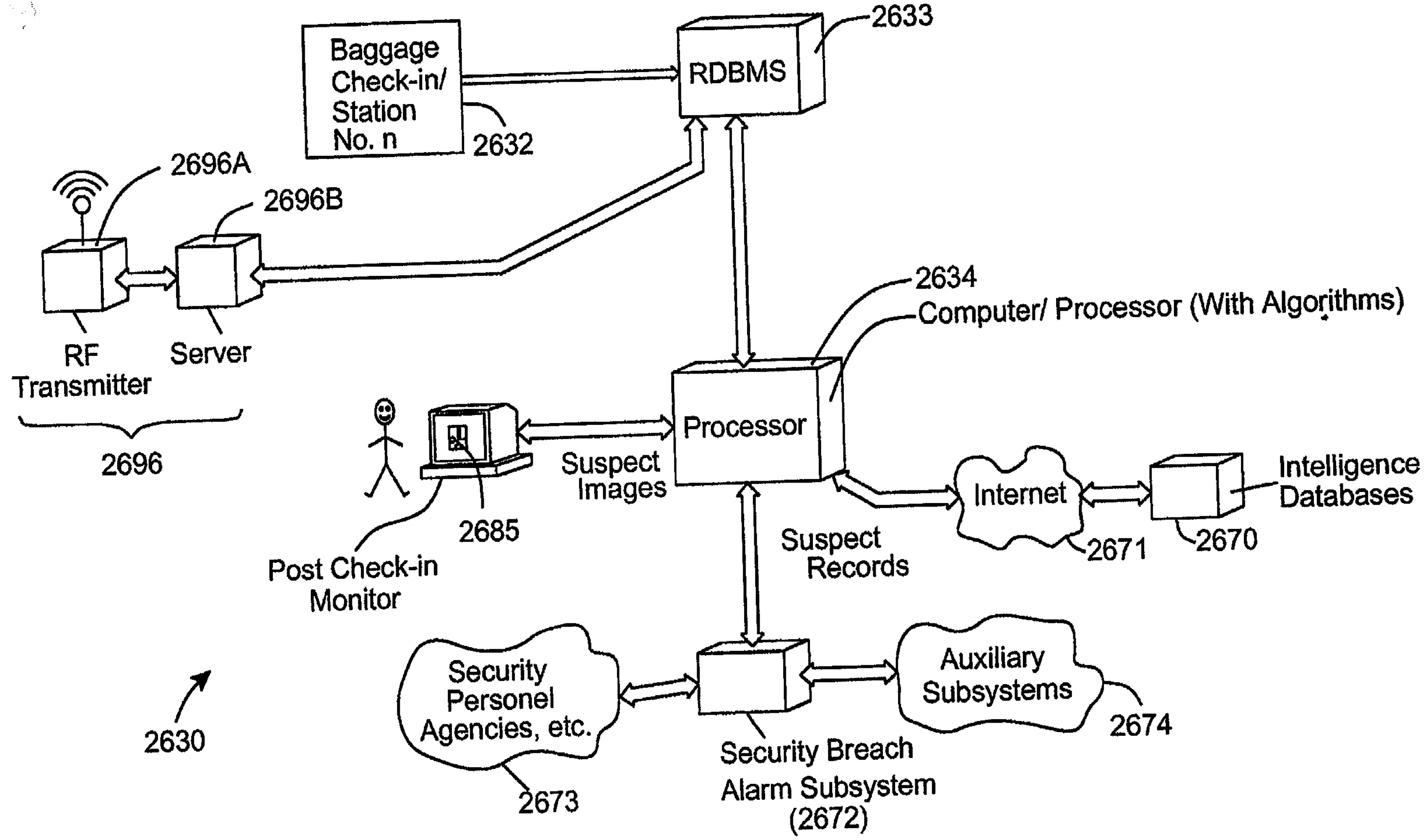

Baggage Check-In/
Screening Station #1
2660
EDS
2650
X-Ray
Scanner
2632
120B
120A
2651
2693
2642
Barcode ID
X-Ray
Monitor
2693
2643
PFNA Data,
Baggage ID,
Dimensional Data
Visible Image
Data, Baggage ID,
Dimensional Data
To RDBMS

FIG. 68-1



"Airport Security System"

FIG. 68-2

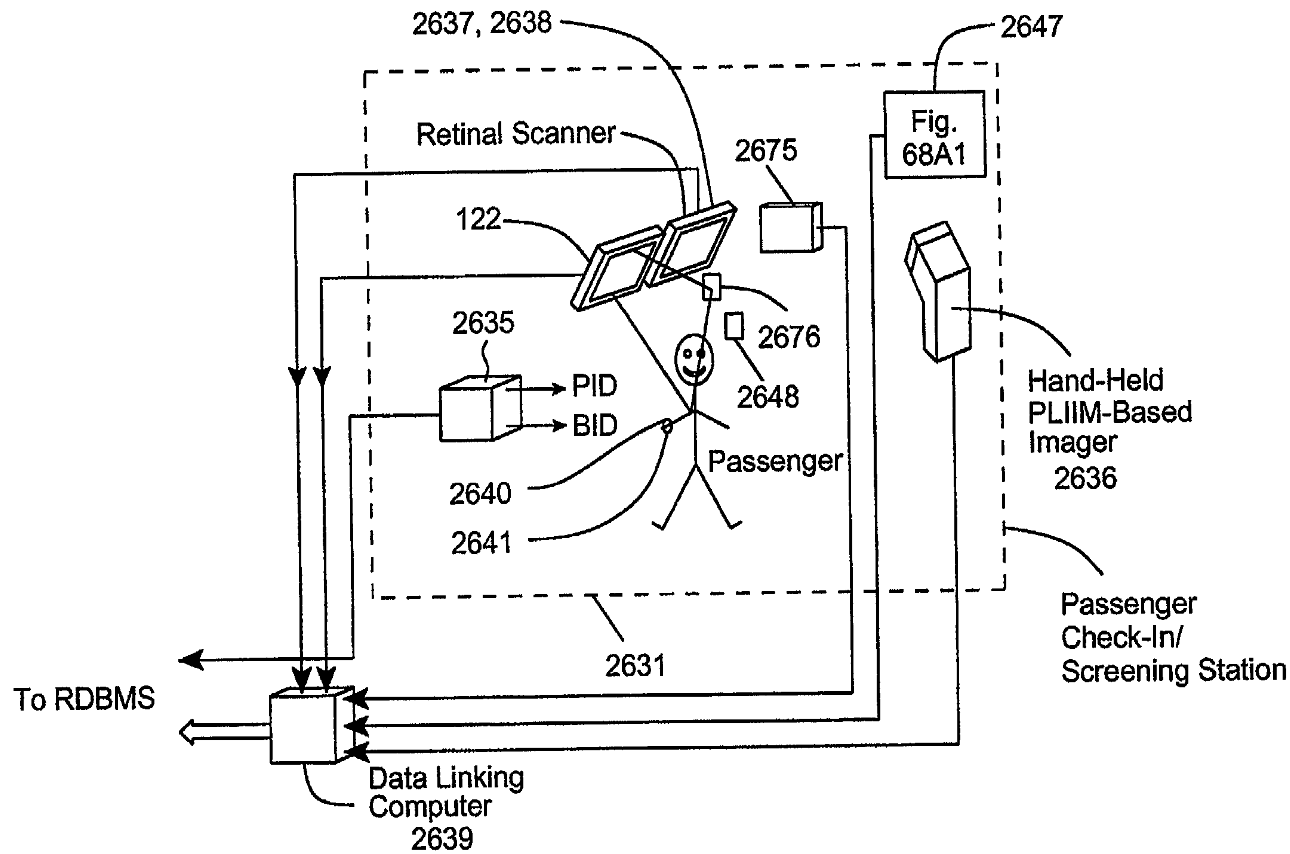

2637, 2638
2647
Retinal Scanner
2675
Fig. 68A1
122
2635
PID
BID
2676
2648
Passenger
2640
2641
Hand-Held PLIIM-Based Imager 2636
2631
Passenger Check-In/ Screening Station
To RDBMS
Data Linking Computer 2639

FIG. 68-3

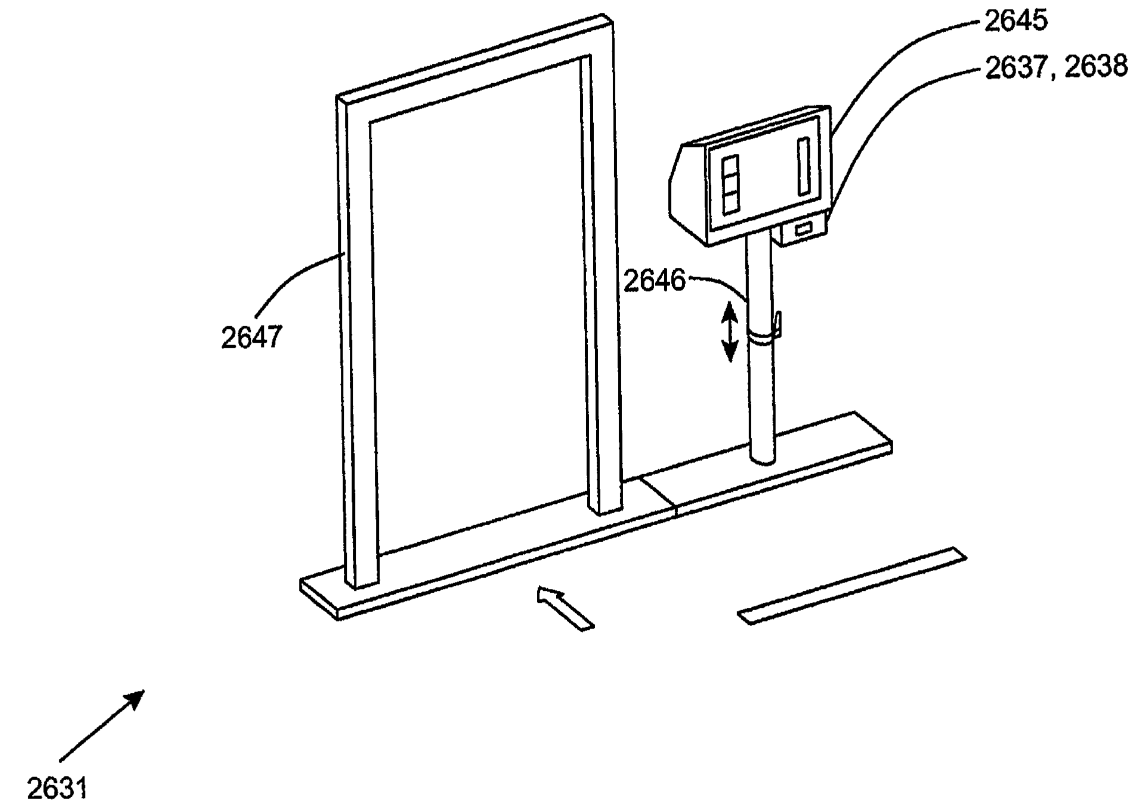


FIG. 68A

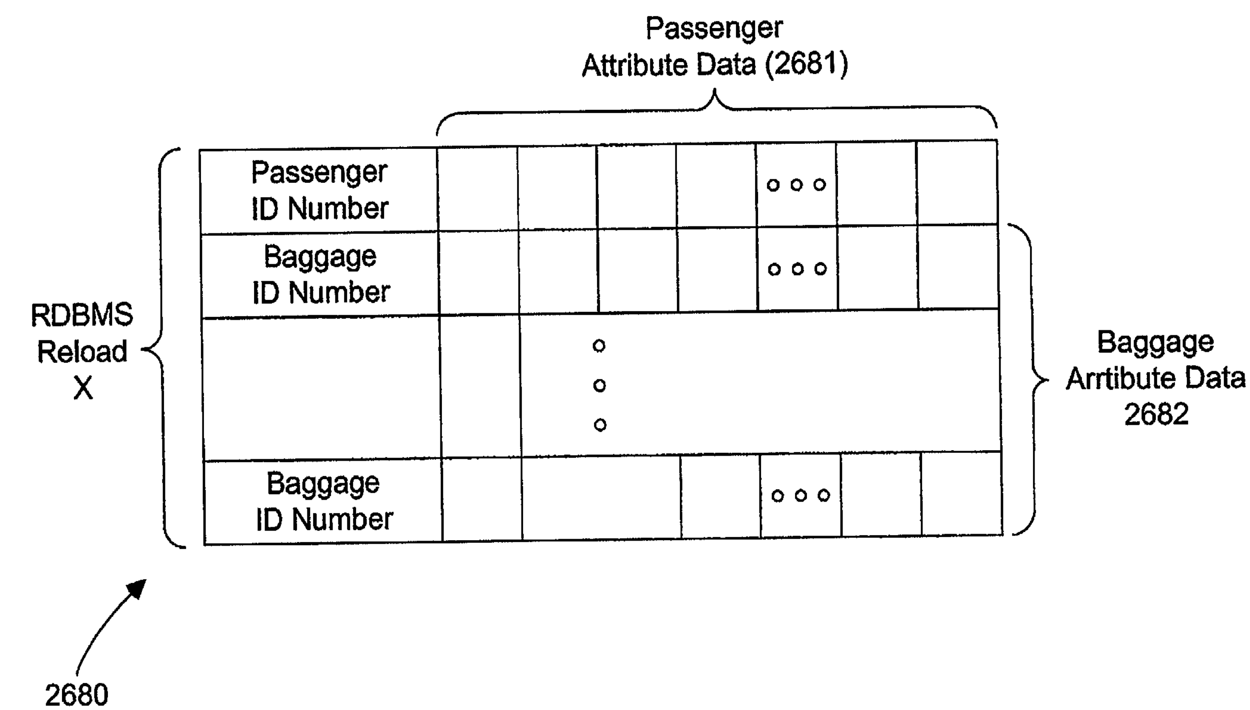

Passenger
Attribute Data (2681)
RDBMS
Reload
X
Passenger
ID Number
Baggage
ID Number
Baggage
ID Number
Baggage
Arrtibute Data
2682
2680

FIG. 68B

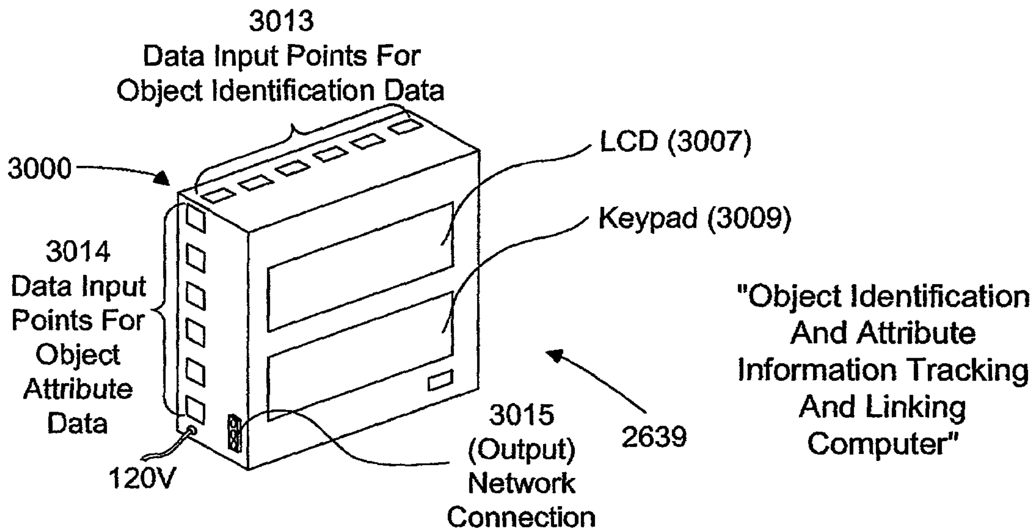


FIG. 68C1

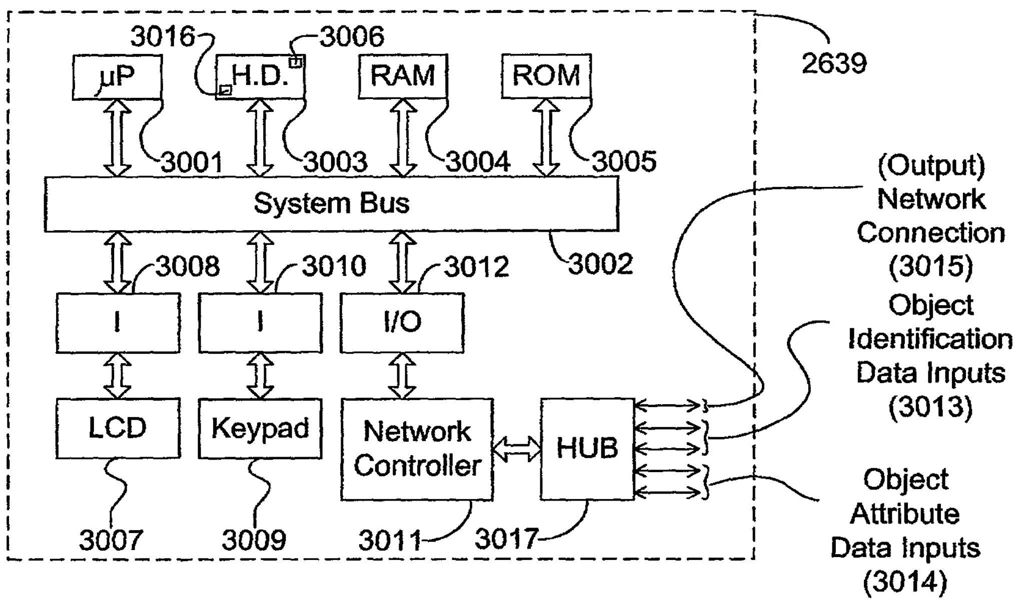


FIG. 68C2

Object Identification And Attribute Information Tracking And Linking Computer System

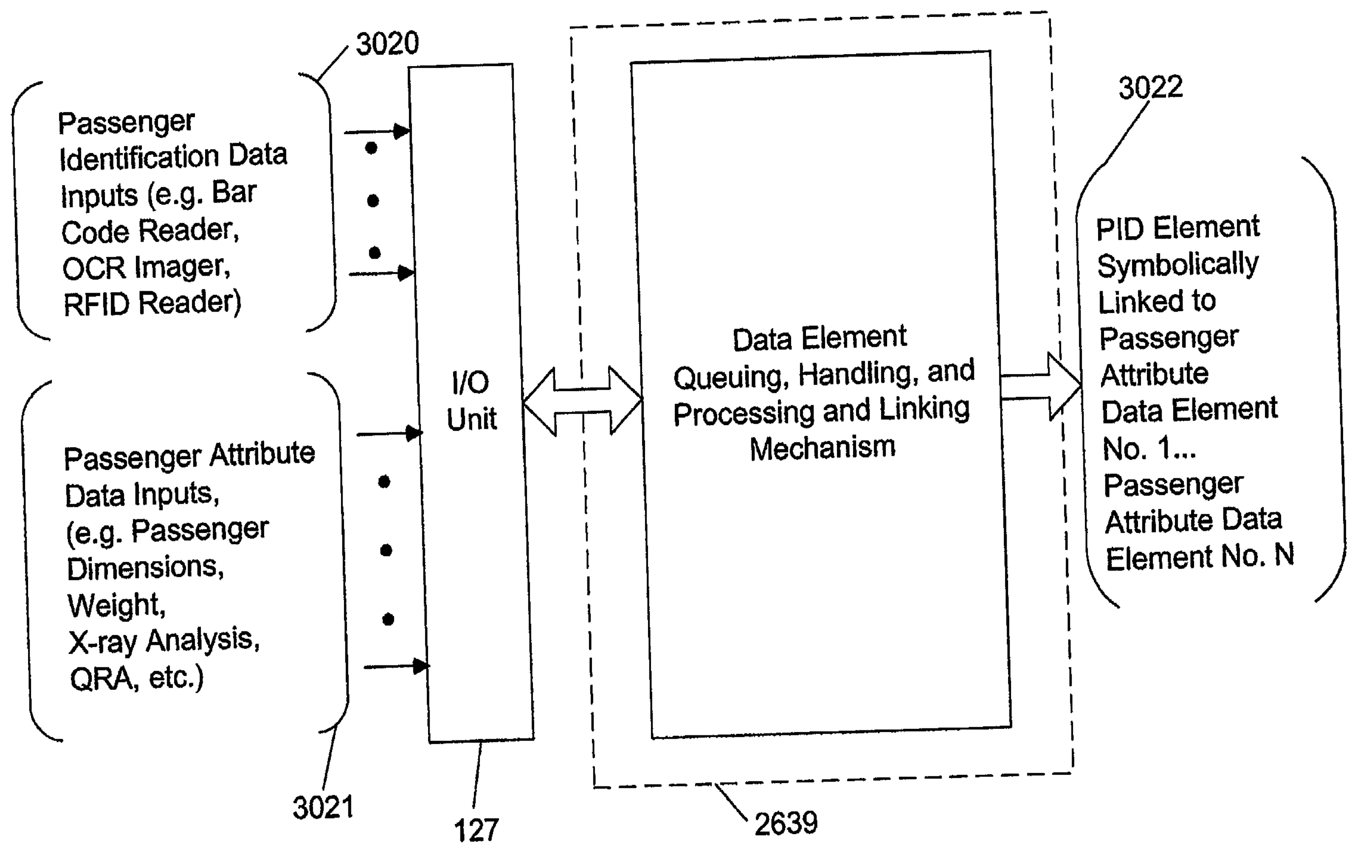


FIG. 68C3

Data Element Queuing, Handling, And Processing Subsystem Employed In The Object Identification And Attribute Acquisition System Of The Present Invention. (131)

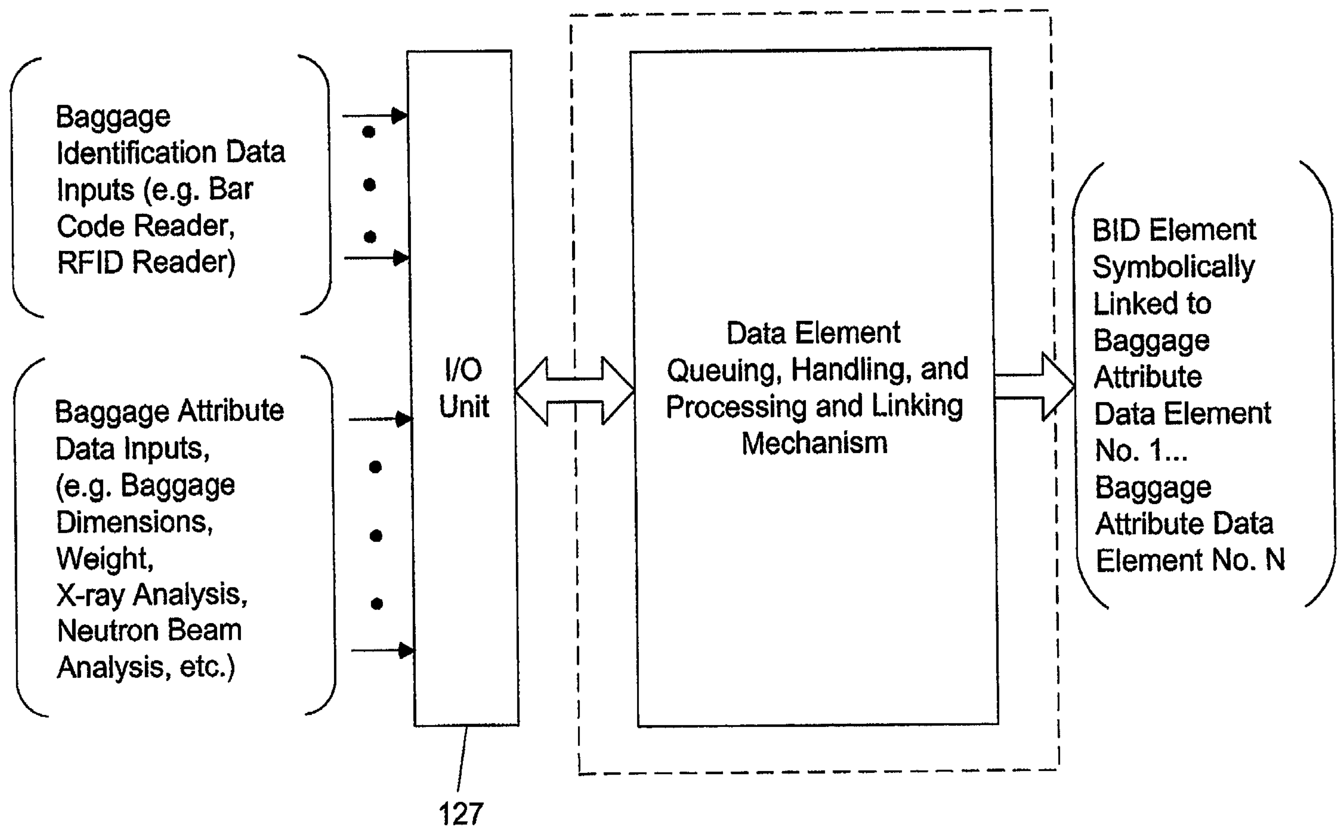


FIG. 68C4

A

Each passenger who is about to board an aircraft at an airport, would first go to check-in station with personal identification (e.g. passport, drivers license, national identification card, etc.) in hand, as well as with articles of baggage to be carried on board by the passenger.

B

Upon checking in with this station, the Passenger Identification (PID) Bar Code Symbol And Baggage Identification (BID) Bar Code Symbol Dispensing Subsystem issues (1) a passenger identification bracelet bearing (or otherwise encoded with) a PID bar code symbol, and (2) a corresponding PID bar code symbol for attachment to each package carried on the aircraft by the passenger. At the same time, this subsystem creates, for each passenger and set of baggage checked into the system at the check-in station, a passenger/baggage information record in the Passenger and Baggage Attribute RDBMS.

C

The passenger identification (PID) bracelet (or identification badge) is affixed to the passenger s person at the passenger check-in station which is to be worn during the entire duration of the passenger' s scheduled flight.

D

The PLIIM-Based Passenger Identification And Profiling Camera Subsystem at the passenger check-in automatically captures (i) a digital image of the passenger s face, head and upper body, (ii) a digital profile of his or her face and head (and possibly body) using the LDIP subsystem employed therein, and (iii) a digital image of the passenger s identification card(s). Other biometric information acquisition devices provided at the passenger check-in station can be used to aquire from each passenger checking-in, passenger attribute information (e.g. retinal pattern information, fingerprint pattern information, voice pattern information, facial pattern information, DNA pattern information) to assist in the reliable identification of the passenger.

E

Each item of passenger attribute information acquired at the passenger check-in station is co-indexed with the corresponding passenger identification (PID) number, and stored in the information records maintained in the Passenger and Baggage Attribute RDBMS, subsequent information processing.

FIG. 68D1

F — Each BID bar coded article of baggage is conveyed through the tunnel-type package identification, dimensioning and tracking subsystem installed before the entry port of the X-radiation baggage scanning subsystem (or integrated there within), and is then conveyed through the X-radiation baggage scanning subsystem. As this scanning process occurs, each bar coded article of baggage is automatically identified, imaged, and dimensioned/ profiled by package identification, dimensioning and tracking subsystem and then imaged by x-radiation scanning subsystem.

↓

G — Each item of baggage attribute information acquired at the baggage check-in station is co-indexed with the corresponding baggage identification (BID) number, and stored in the information records maintained in the Passenger and Baggage Attribute RDBMS, subsequent information processing.

↓

H — Each BID bar coded article of baggage is conveyed through a second tunnel-type package identification, dimensioning and tracking subsystem installed downstream, before the entry port of the automated explosive detection subsystem EDS (or integrated there within), and is conveyed through the EDS.

↓

I — At the EDS station, each bar coded article of baggage is automatically identified, imaged, and dimensioned/ profiled by package identification, dimensioning and tracking subsystem and then analyzed by EDS.

↓

J — Each item of baggage attribute information acquired at the EDS station is co-indexed with the corresponding baggage identification (BID) number, and stored in the information records maintained in the Passenger and Baggage Attribute RDBMS, subsequent information processing.

FIG. 68D2

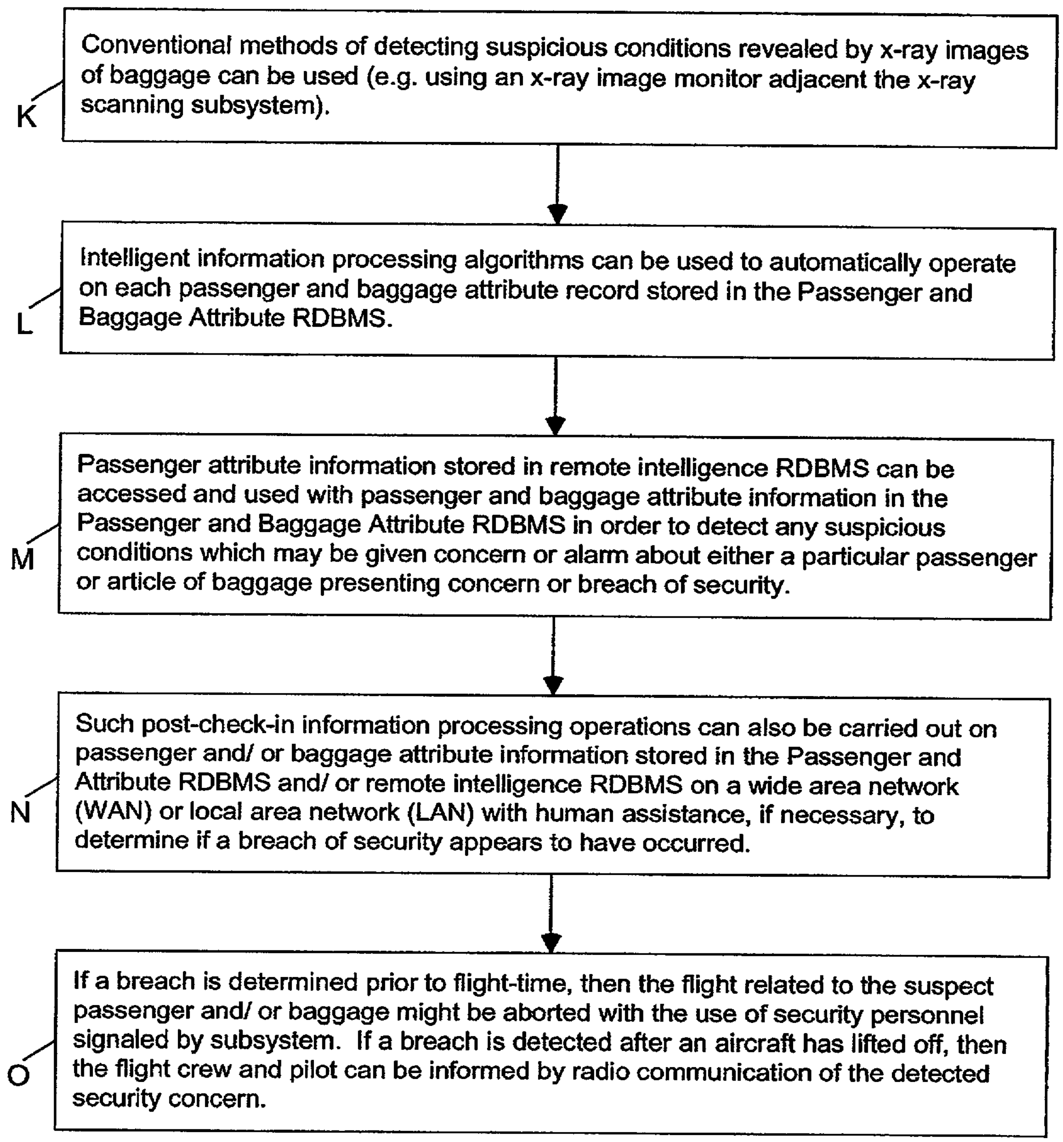
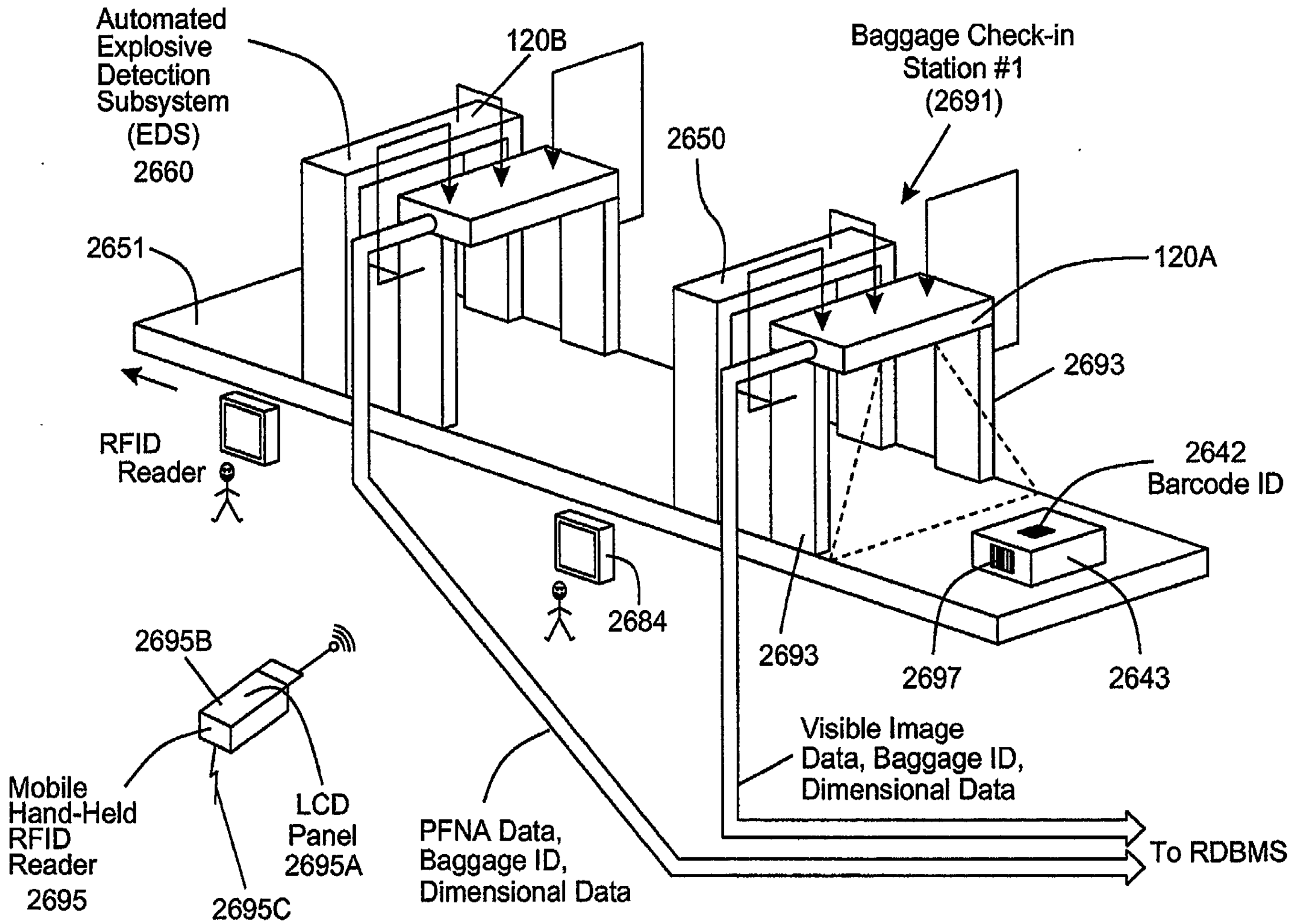

K
Conventional methods of detecting suspicious conditions revealed by x-ray images of baggage can be used (e.g. using an x-ray image monitor adjacent the x-ray scanning subsystem).
L
Intelligent information processing algorithms can be used to automatically operate on each passenger and baggage attribute record stored in the Passenger and Baggage Attribute RDBMS.
M
Passenger attribute information stored in remote intelligence RDBMS can be accessed and used with passenger and baggage attribute information in the Passenger and Baggage Attribute RDBMS in order to detect any suspicious conditions which may be given concern or alarm about either a particular passenger or article of baggage presenting concern or breach of security.
N
Such post-check-in information processing operations can also be carried out on passenger and/ or baggage attribute information stored in the Passenger and Attribute RDBMS and/ or remote intelligence RDBMS on a wide area network (WAN) or local area network (LAN) with human assistance, if necessary, to determine if a breach of security appears to have occurred.
O
If a breach is determined prior to flight-time, then the flight related to the suspect passenger and/ or baggage might be aborted with the use of security personnel signaled by subsystem. If a breach is detected after an aircraft has lifted off, then the flight crew and pilot can be informed by radio communication of the detected security concern.

FIG. 68D3



Automated Explosive Detection Subsystem (EDS) 2660
120B
Baggage Check-in Station #1 (2691)
2650
2651
120A
2693
RFID Reader
2642 Barcode ID
2684
2693
2697
2643
2695B
Mobile Hand-Held RFID Reader 2695
LCD Panel 2695A
2695C
PFNA Data, Baggage ID, Dimensional Data
Visible Image Data, Baggage ID, Dimensional Data
To RDBMS

FIG. 69-1

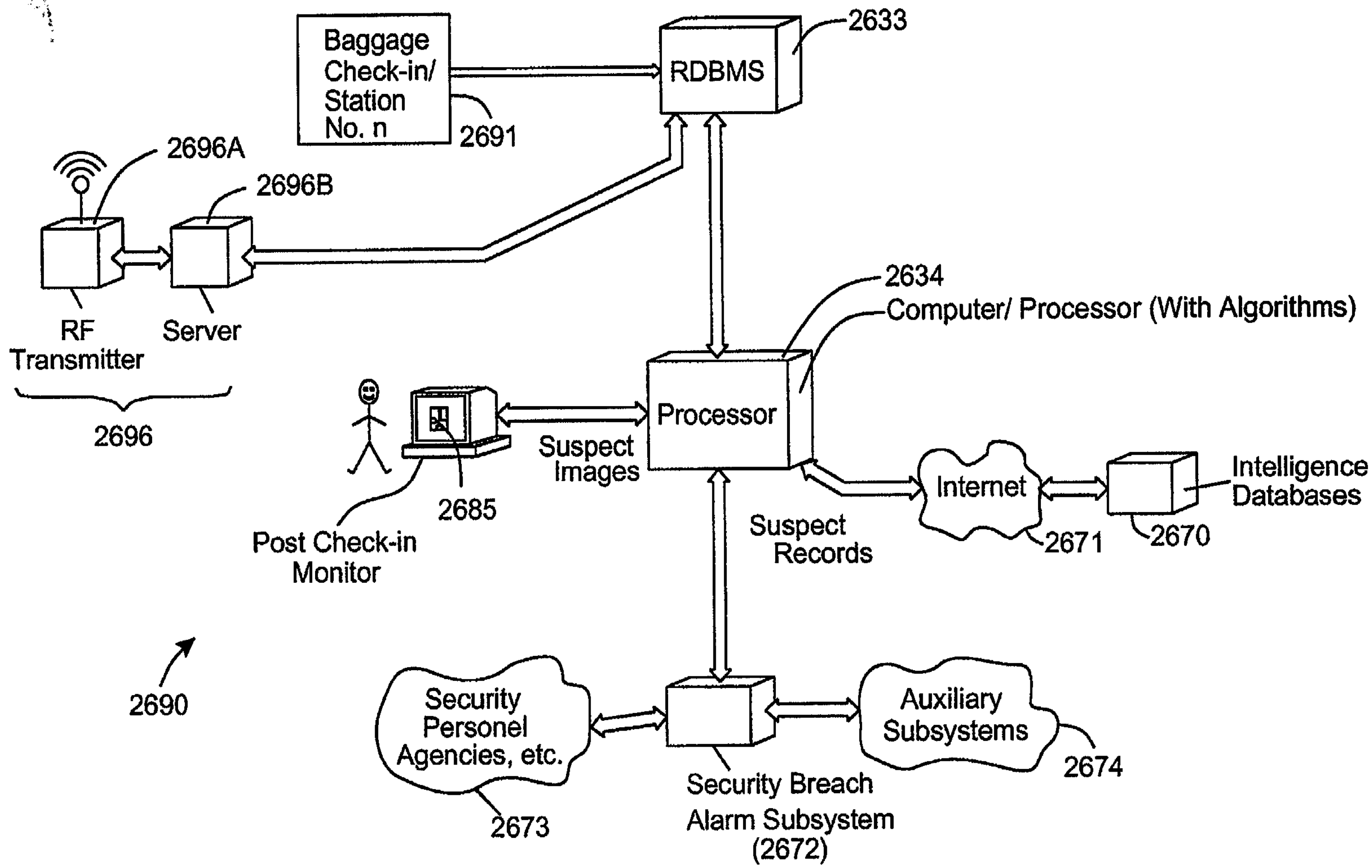


FIG. 69-2

079/397

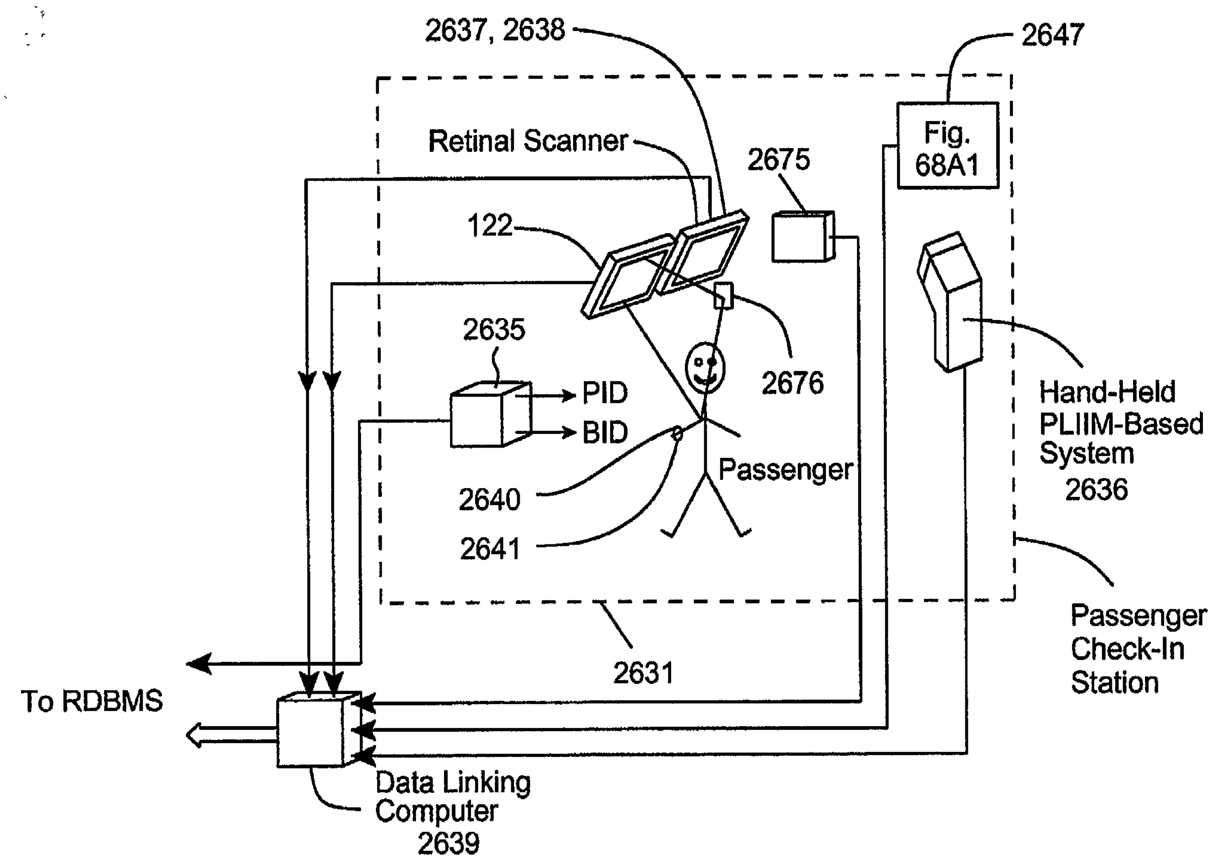

2637, 2638
2647
Retinal Scanner
2675
Fig. 68A1
122
2635
PID
BID
2676
Passenger
2640
2641
Hand-Held PLIIM-Based System 2636
Passenger Check-In Station
2631
To RDBMS
Data Linking Computer 2639

FIG. 69-3

A — Each passenger who is about to board an aircraft at an airport, would first go to check-in station with personal identification (e.g. passport, drivers license, national identification card, etc.) in hand, as well as with articles of baggage to be carried on board by the passenger.

B — Upon checking in with this station, the Passenger Identification (PID) Bar Code Symbol And Baggage Identification (BID) Bar Code Symbol Dispensing Subsystem issues (1) a passenger identification bracelet bearing (or otherwise encoded with) a PID bar code symbol, and (2) a corresponding PID bar code symbol for attachment to each package carried on the aircraft by the passenger. At the same time, this subsystem creates, for each passenger and set of baggage checked into the system at the check-in station, a passenger/baggage information record in the Passenger and Baggage Attribute RDBMS.

C — The passenger identification (PID) bracelet (or identification badge) is affixed to the passenger s person at the passenger check-in station which is to be worn during the entire duration of the passenger' s scheduled flight.

D — The PLIIM-Based Passenger Identification And Profiling Camera Subsystem at the passenger check-in automatically captures (i) a digital image of the passenger s face, head and upper body, (ii) a digital profile of his or her face and head (and possibly body) using the LDIP subsystem employed therein, and (iii) a digital image of the passenger s identification card(s). Other biometric information acquisition devices provided at the passenger check-in station can be used to aquire from each passenger checking-in, passenger attribute information (e.g. retinal pattern information, fingerprint pattern information, voice pattern information, facial pattern information, DNA pattern information) to assist in the reliable identification of the passenger.

E — Each item of passenger attribute information acquired at the passenger check-in station is co-indexed with the corresponding passenger identification (PID) number, and stored in the information records maintained in the Passenger and Baggage Attribute RDBMS, subsequent information processing.

FIG. 69B1

F
Each BID bar coded article of baggage is conveyed through the tunnel-type package identification, dimensioning and tracking subsystem installed before the entry port of the X-radiation baggage scanning subsystem (or integrated there within), and is then conveyed through the X-radiation baggage scanning subsystem. As this scanning process occurs, each bar coded article of baggage is automatically identified, imaged, and dimensioned/ profiled by package identification, dimensioning and tracking subsystem and then imaged by x-radiation scanning subsystem.

G
Each item of baggage attribute information acquired at the baggage check-in station is co-indexed with the corresponding baggage identification (BID) number, and stored in the information records maintained in the Passenger and Baggage Attribute RDBMS, subsequent information processing.

H
Each BID bar coded article of baggage is conveyed through a second tunnel-type package identification, dimensioning and tracking subsystem installed downstream, before the entry port of the automated explosive detection subsystem EDS (or integrated there within), and is conveyed through the EDS.

I
At the EDS station, each bar coded article of baggage is automatically identified, imaged, and dimensioned/ profiled by package identification, dimensioning and tracking subsystem and then analyzed by EDS.

J
Each item of baggage attribute information acquired at the EDS station is co-indexed with the corresponding baggage identification (BID) number, and stored in the information records maintained in the Passenger and Baggage Attribute RDBMS, subsequent information processing.

FIG. 69B2

K — Conventional methods of detecting suspicious conditions revealed by x-ray images of baggage can be used (e.g. using an x-ray image monitor adjacent the x-ray scanning subsystem).

↓

L — Intelligent information processing algorithms can be used to automatically operate on each passenger and baggage attribute record stored in the Passenger and Baggage Attribute RDBMS.

↓

M — Passenger attribute information stored in remote intelligence RDBMS can be accessed and used with passenger and baggage attribute information in the Passenger and Baggage Attribute RDBMS in order to detect any suspicious conditions which may be given concern or alarm about either a particular passenger or article of baggage presenting concern or breach of security.

↓

N — Such post-check-in information processing operations can also be carried out on passenger and/ or baggage attribute information stored in the Passenger and Attribute RDBMS and/ or remote intelligence RDBMS on a wide area network (WAN) or local area network (LAN) with human assistance, if necessary, to determine if a breach of security appears to have occurred.

↓

O — If a breach is determined prior to flight-time, then the flight related to the suspect passenger and/ or baggage might be aborted with the use of security personnel signaled by subsystem. If a breach is detected after an aircraft has lifted off, then the flight crew and pilot can be informed by radio communication of the detected security concern.

FIG. 69B3

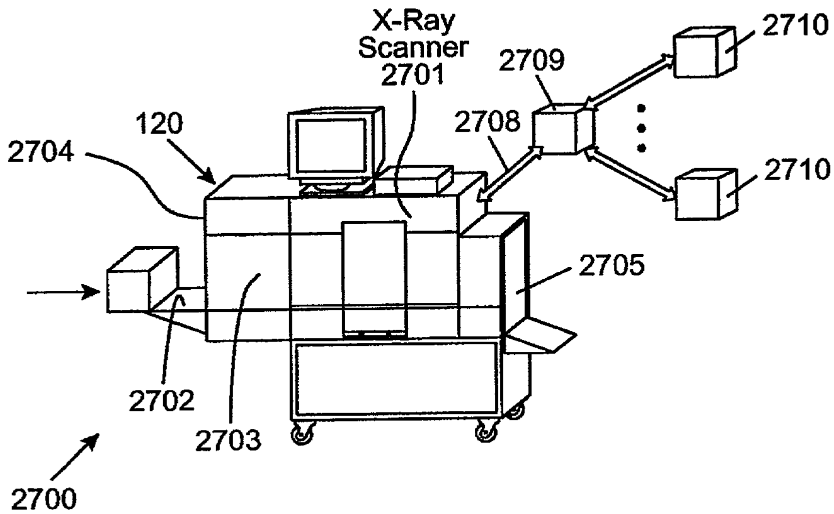


FIG. 70A

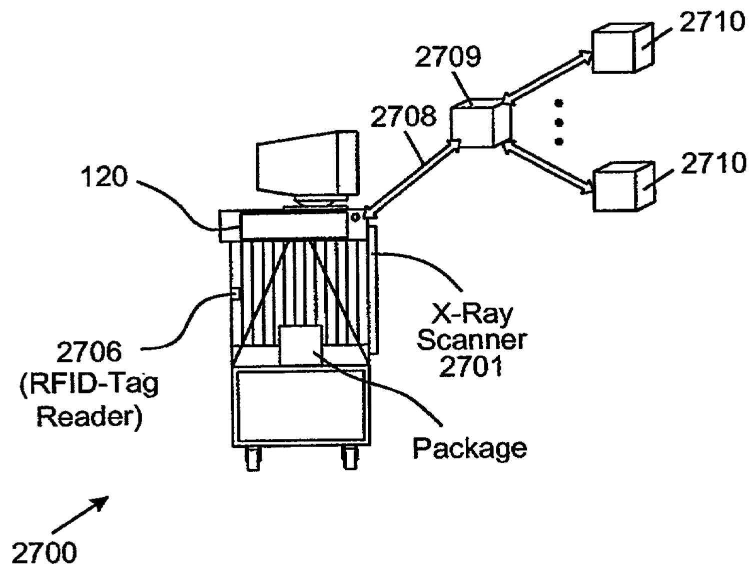


FIG. 70B

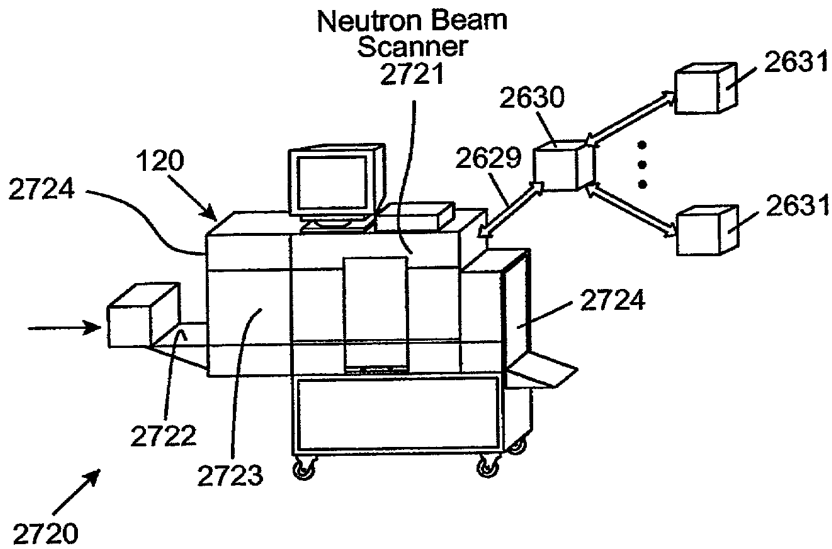


FIG. 71A

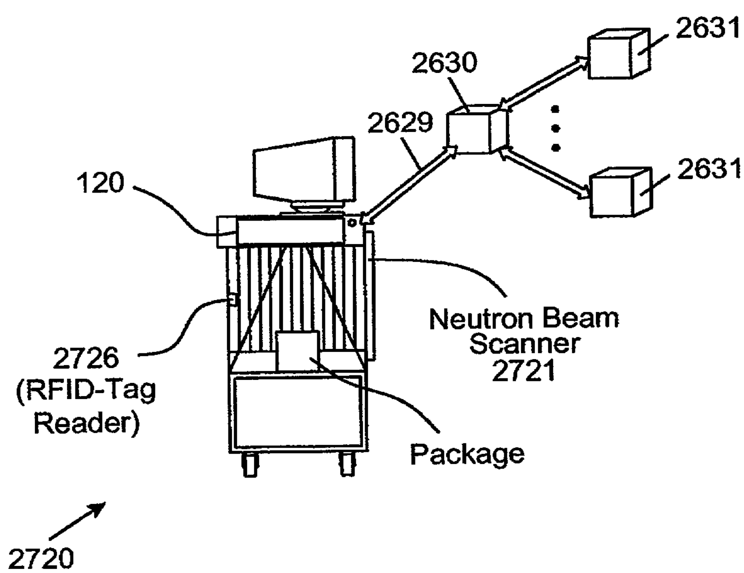


FIG. 71B

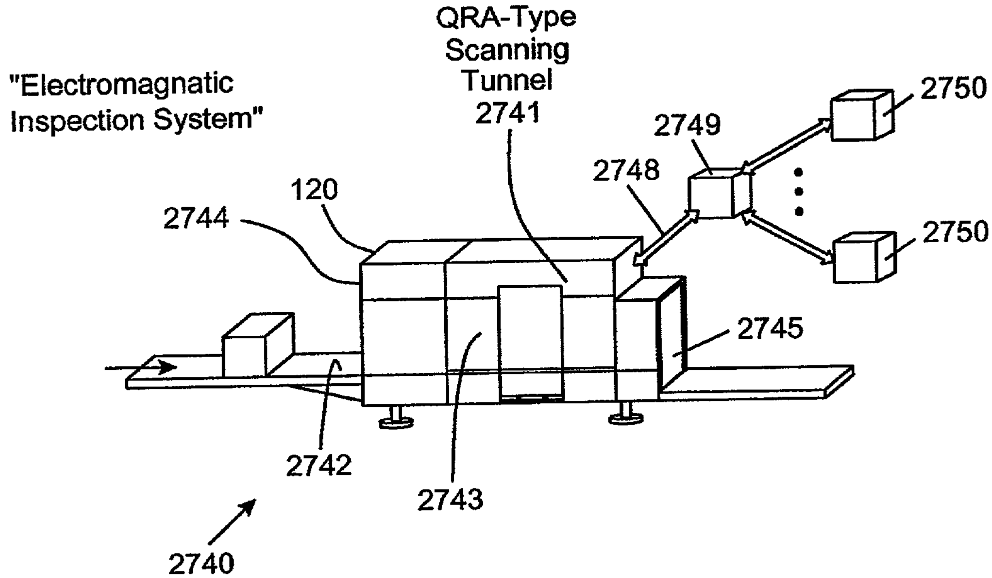


FIG. 72A

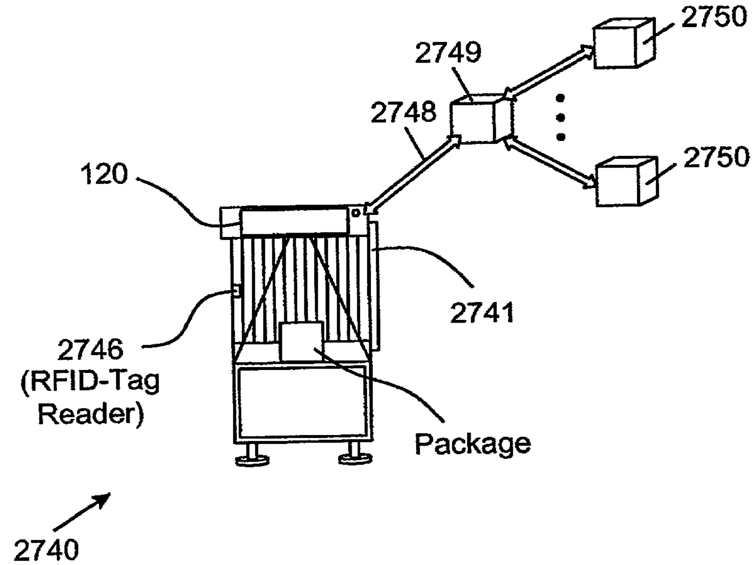


FIG. 72B

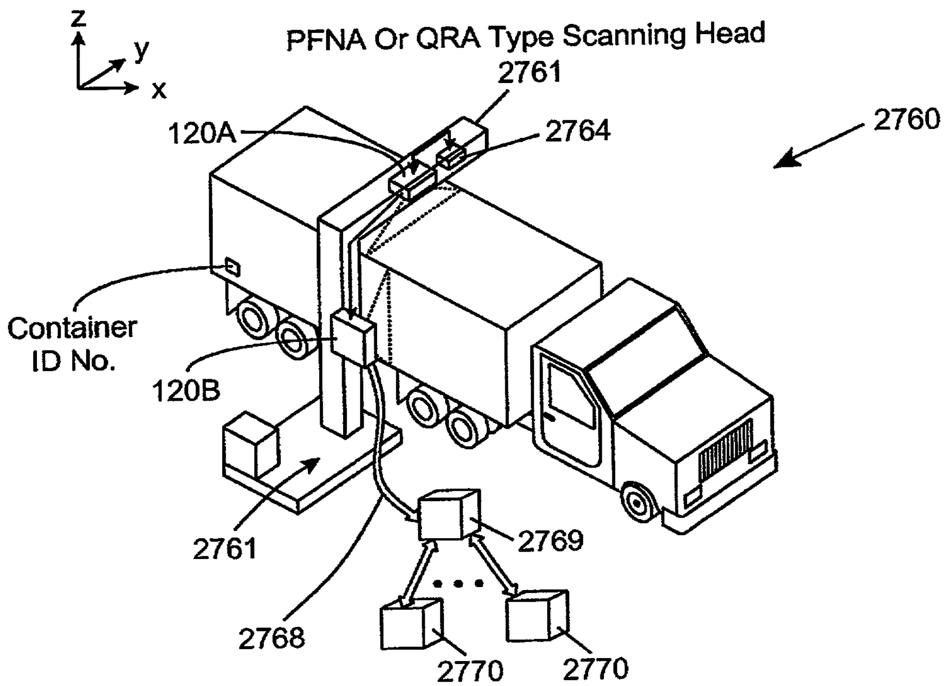

z
y
x
PFNA Or QRA Type Scanning Head
2761
2760
120A
2764
Container ID No.
120B
2761
2769
2768
2770
2770

FIG. 73

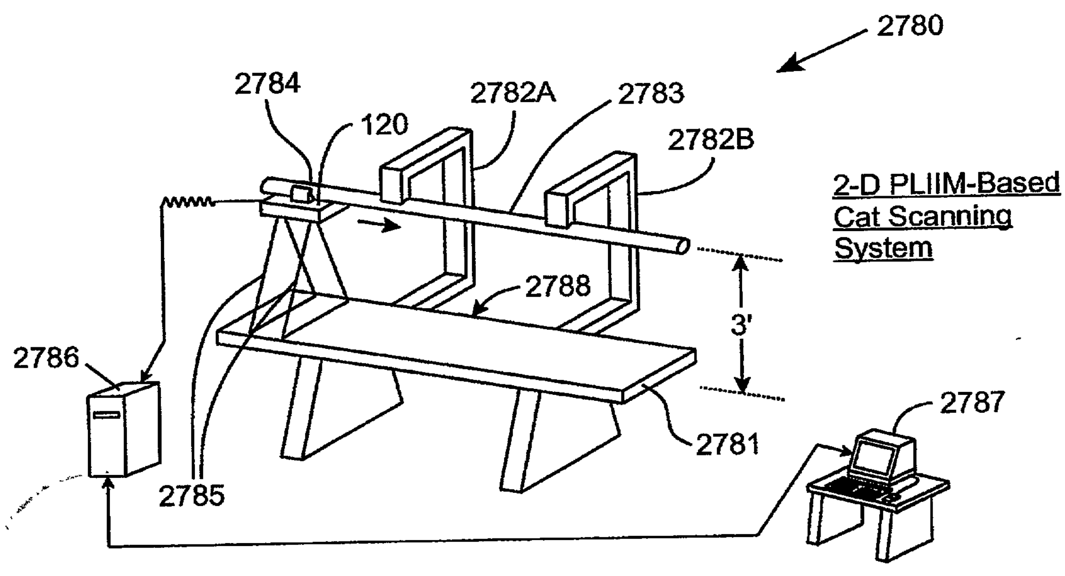

2780
2784
2782A
2783
120
2782B
2-D PLIIM-Based Cat Scanning System
2788
3'
2786
2787
2781
2785

FIG. 74

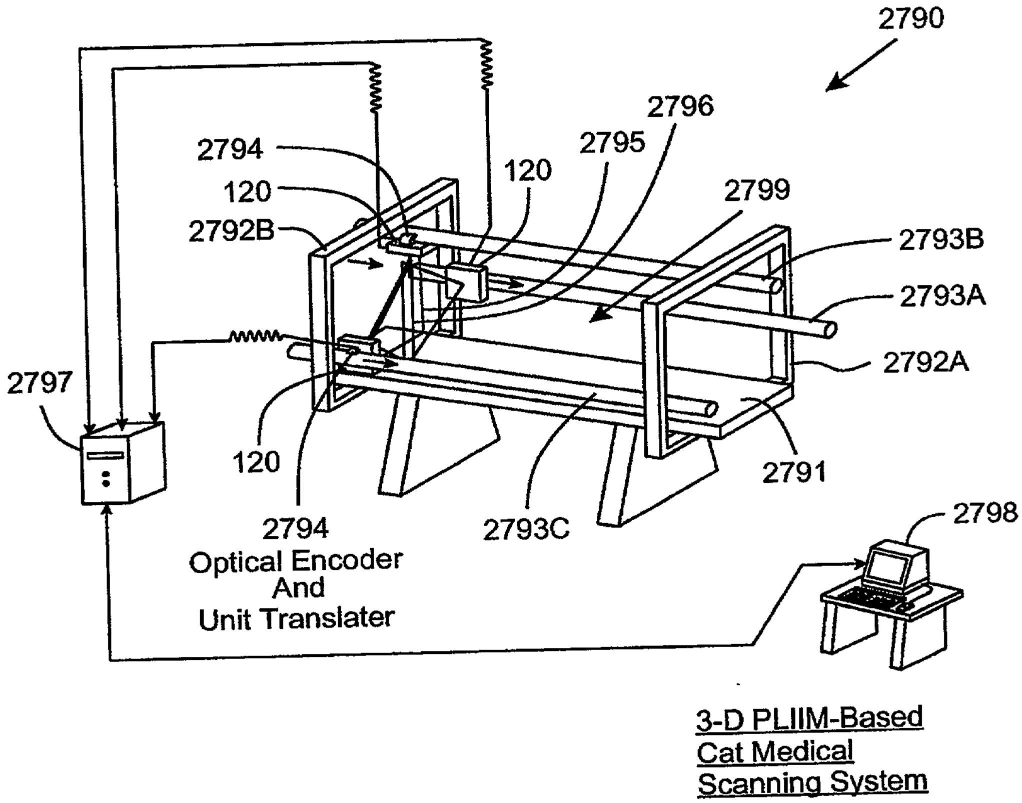

2790
2796
2795
2794
120
120
2799
2792B
2793B
2793A
2792A
2797
120
2791
2794
Optical Encoder
And
Unit Translater
2793C
2798
3-D PLIIM-Based
Cat Medical
Scanning System

FIG. 75

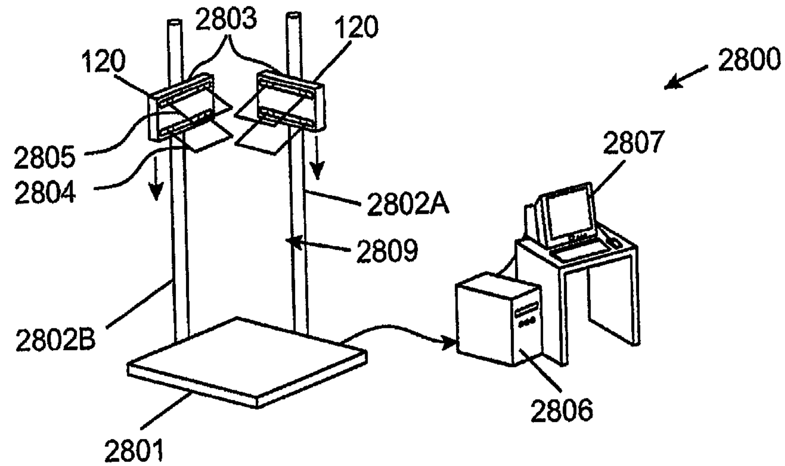


FIG. 76

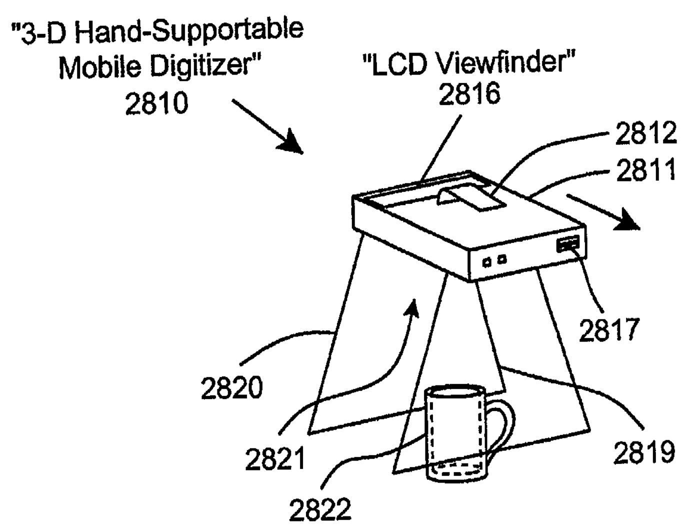


FIG. 77A

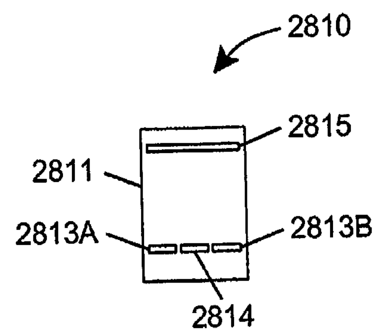


FIG. 77B

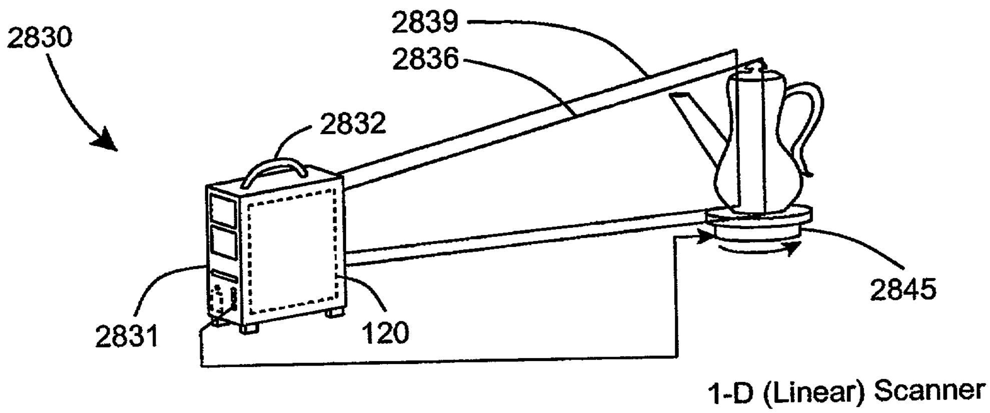


FIG. 78A

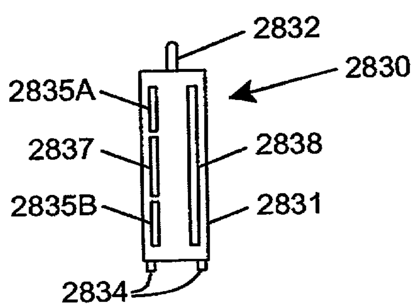


FIG. 78B

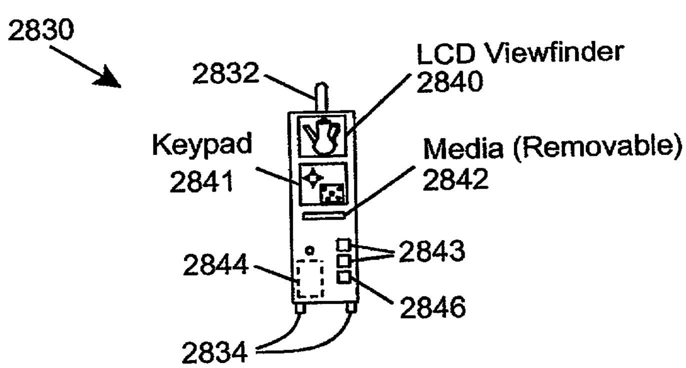


FIG. 78C

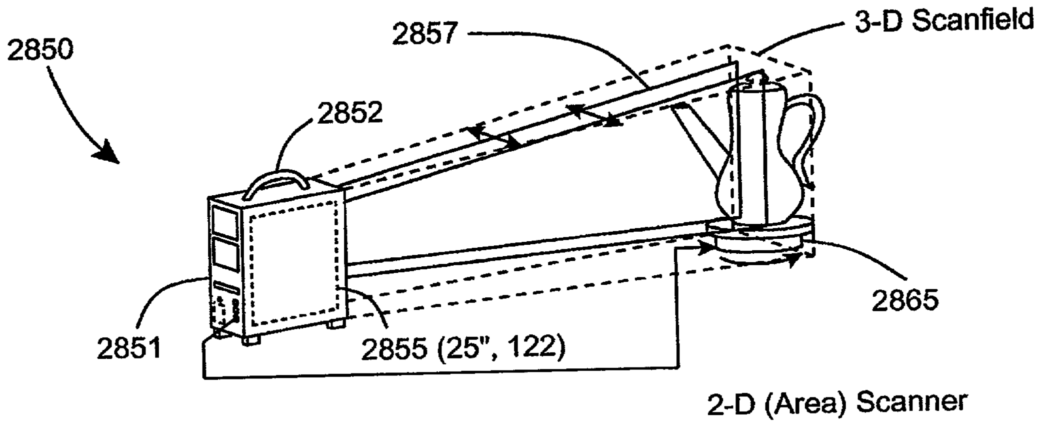


FIG. 79A

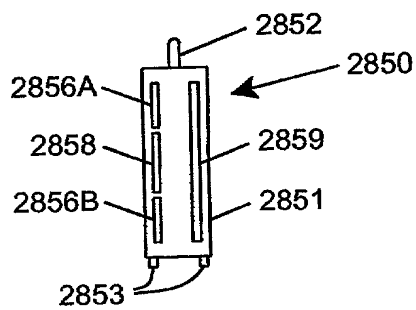


FIG. 79B

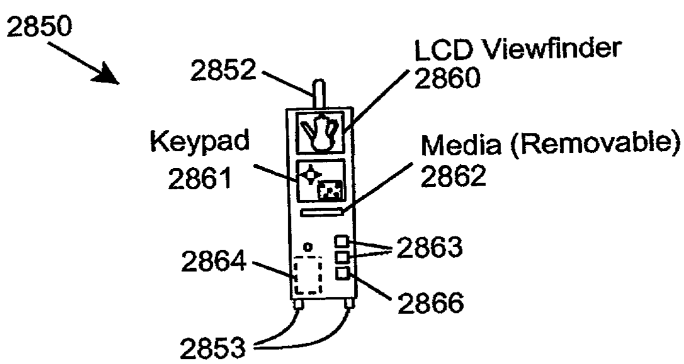


FIG. 79C

Automatic Vehicle Identification (AVI)

System Of Present Invention

* Employing Overhead Profiling
  And Imaging During
  License Plate Image Capture

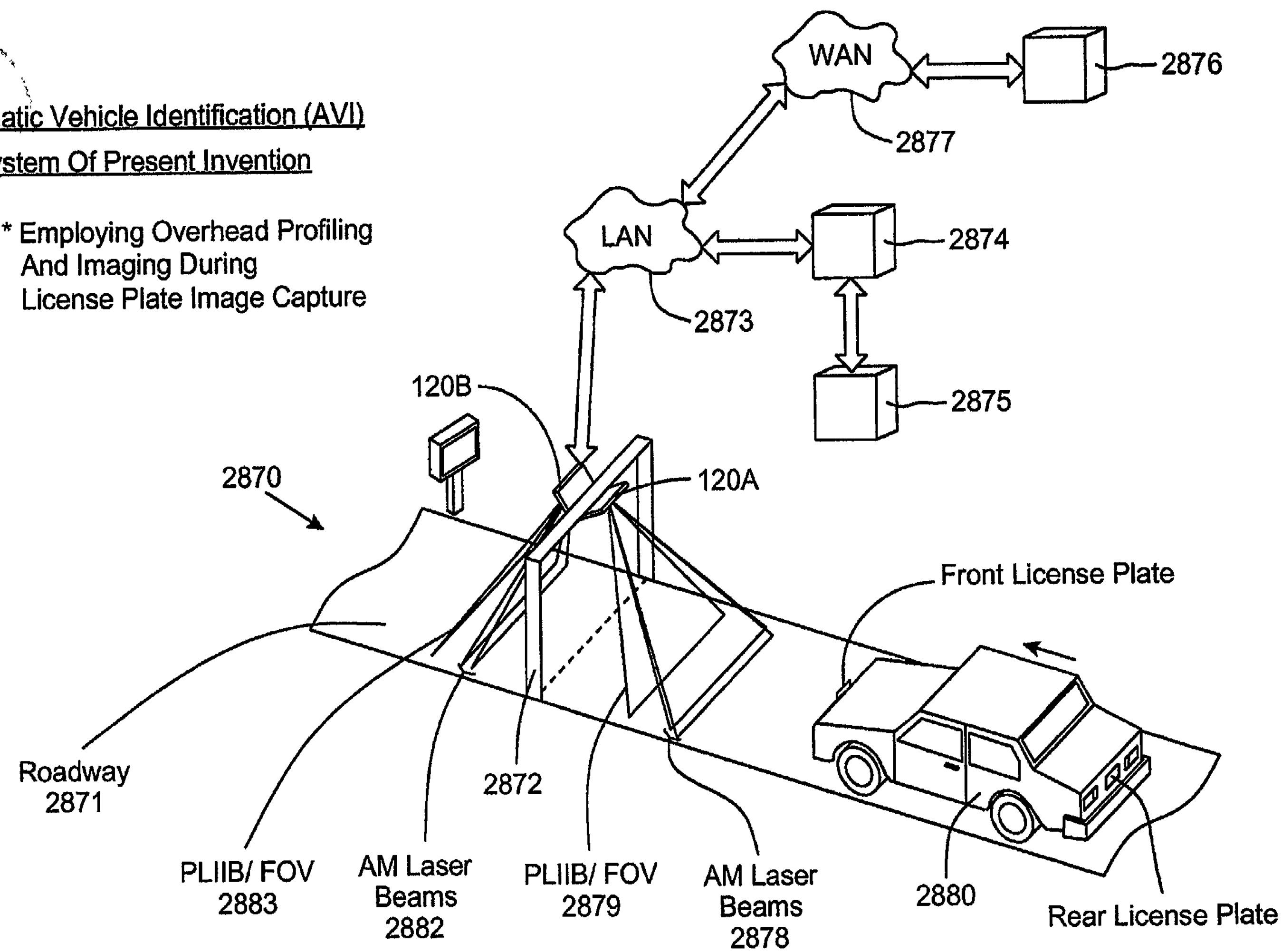


FIG. 80

Automatic Vehicle Identification (AVI)

System Of Present Invention

* Employing Overhead Profiling And Imaging Techniques During License Plate Image Capture

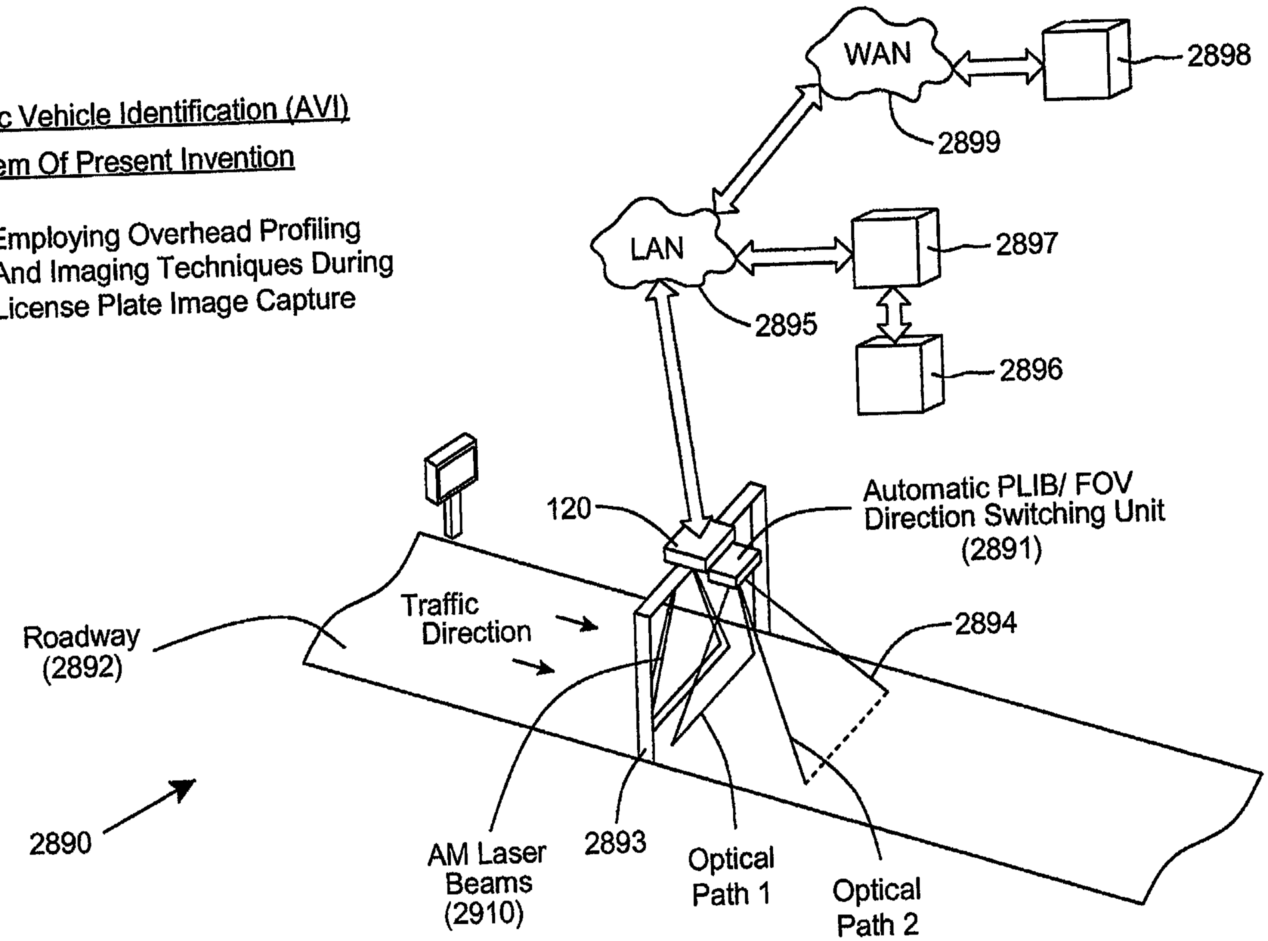


FIG. 81A

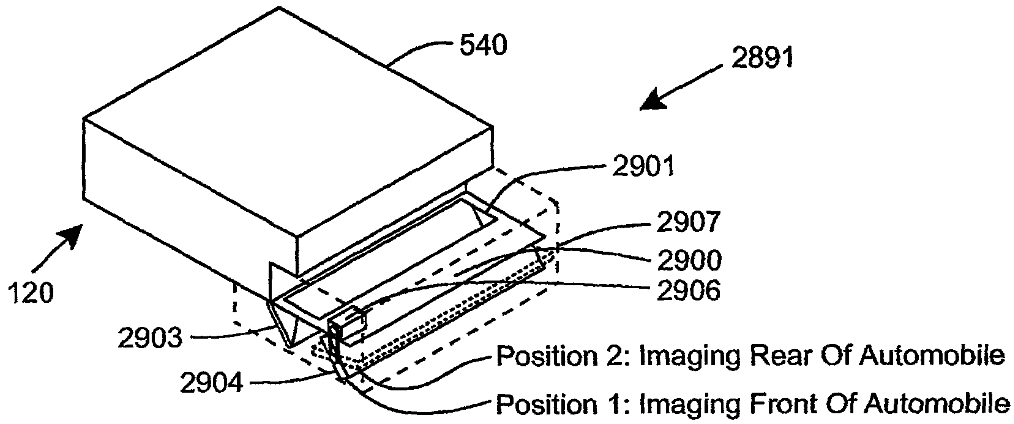


FIG. 81B

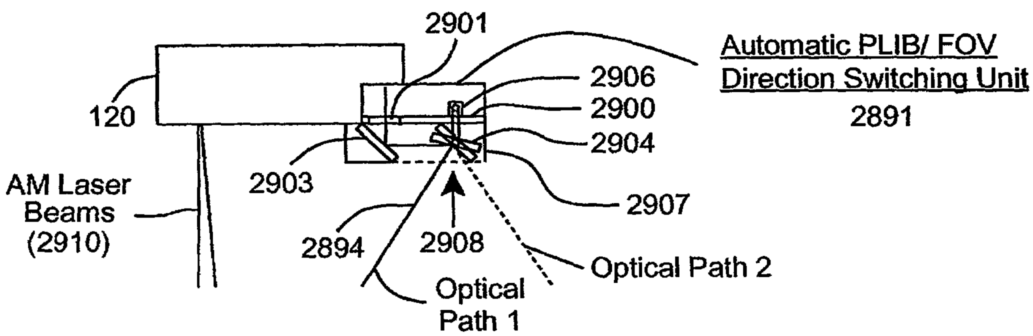


FIG. 81C

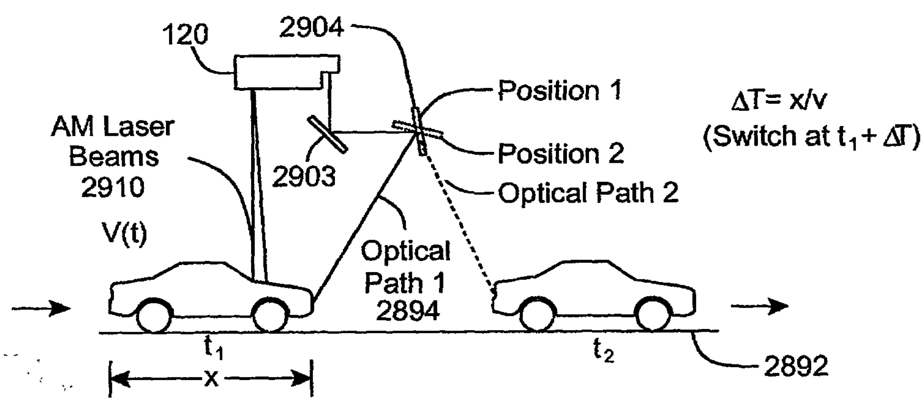
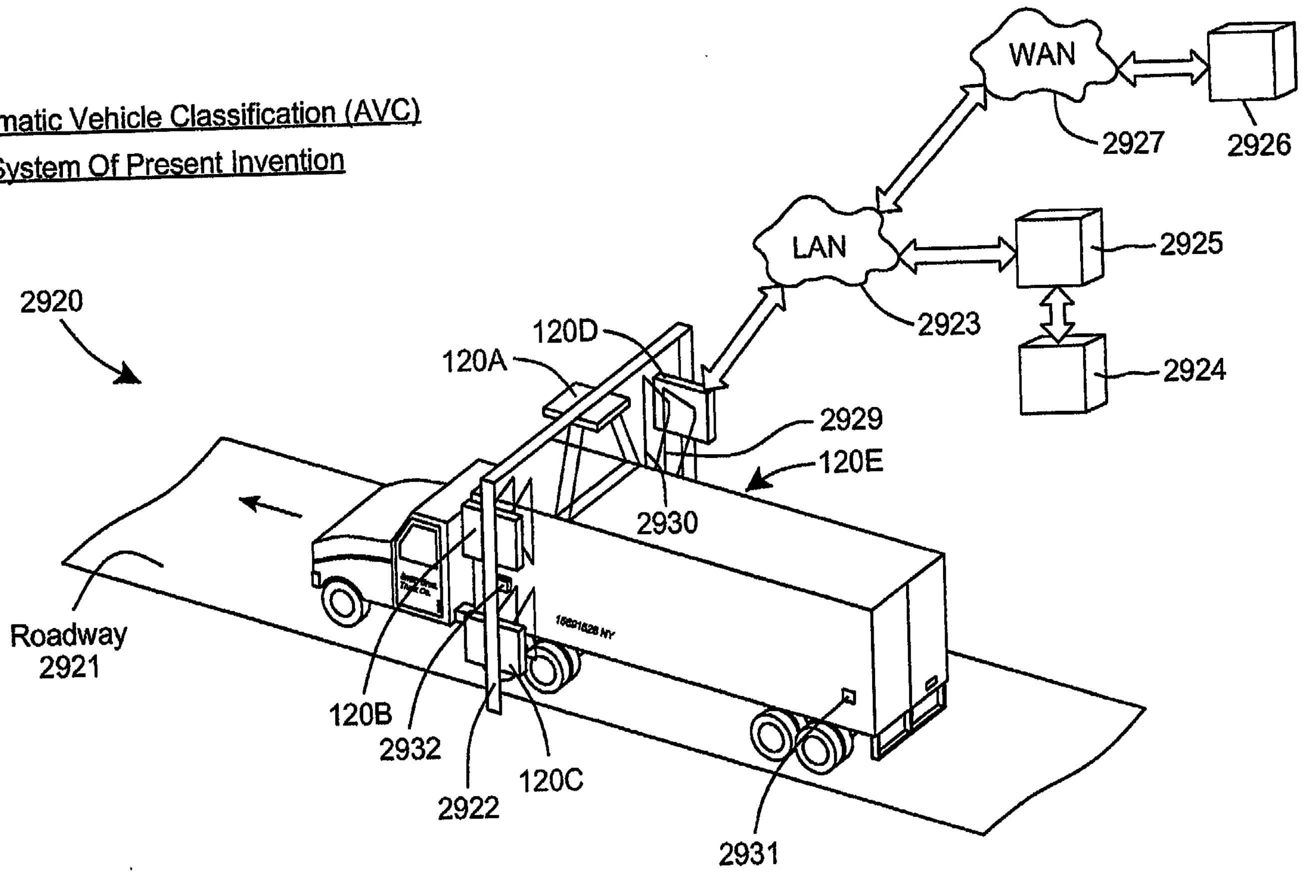


FIG. 81D

Automatic Vehicle Classification (AVC)
System Of Present Invention



* Employing Overhead And Lateral Profiling And Imaging Techniques

FIG. 82

Automatic Vehicle Identification And Classification (AVIC) System Of The Present Invention

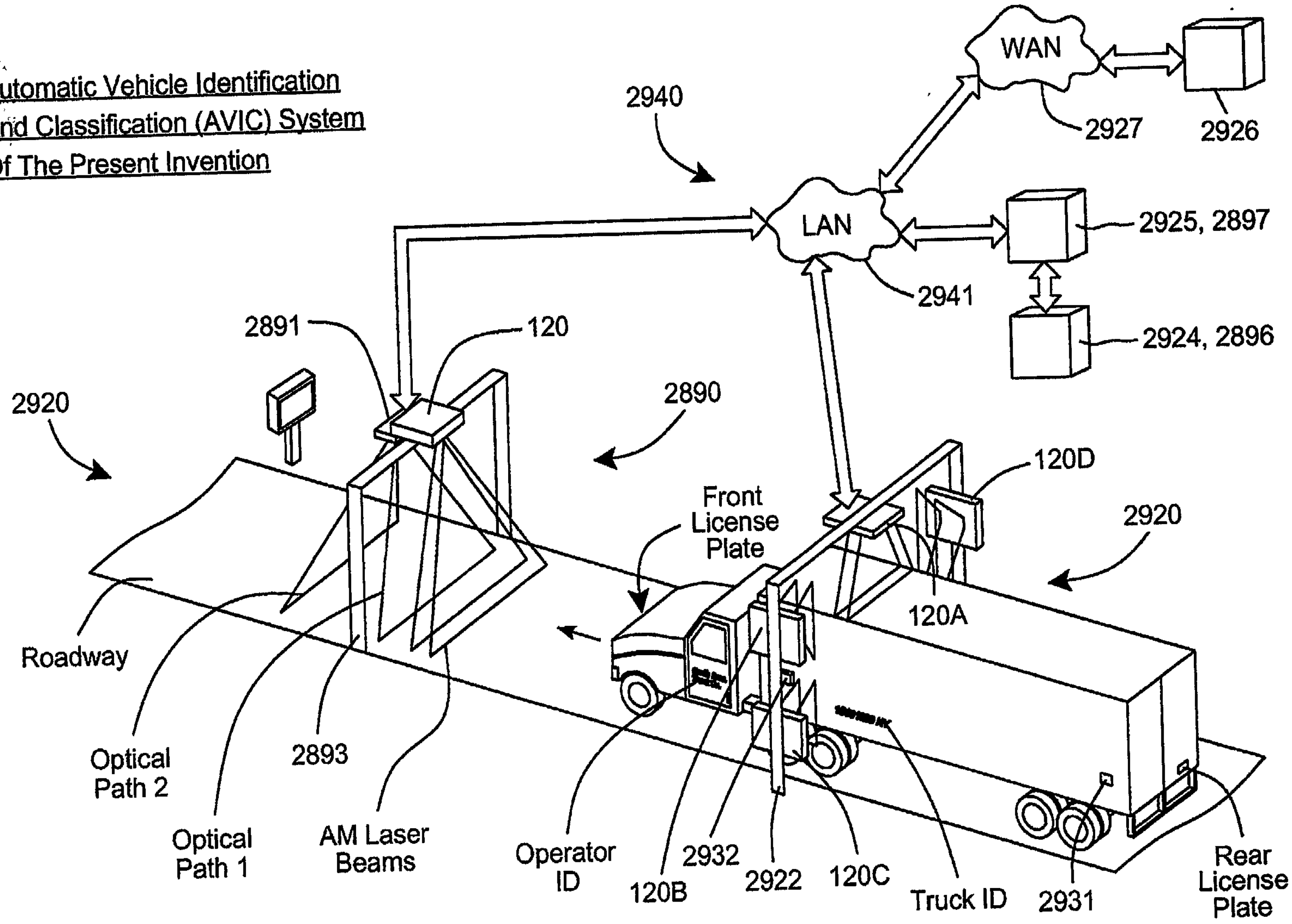


FIG. 83

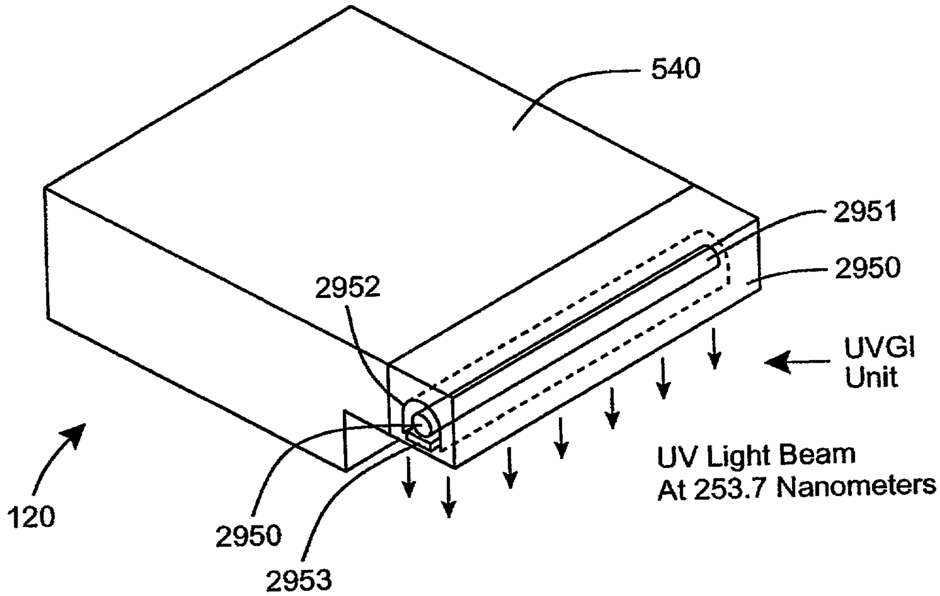


FIG. 84A

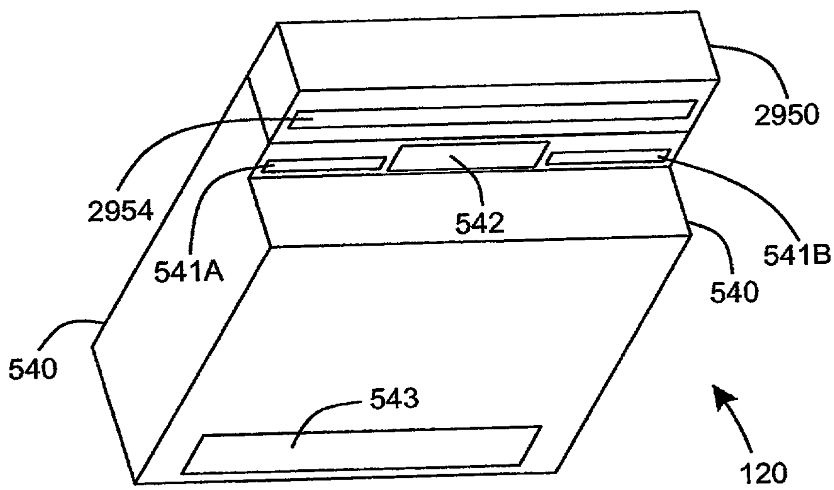
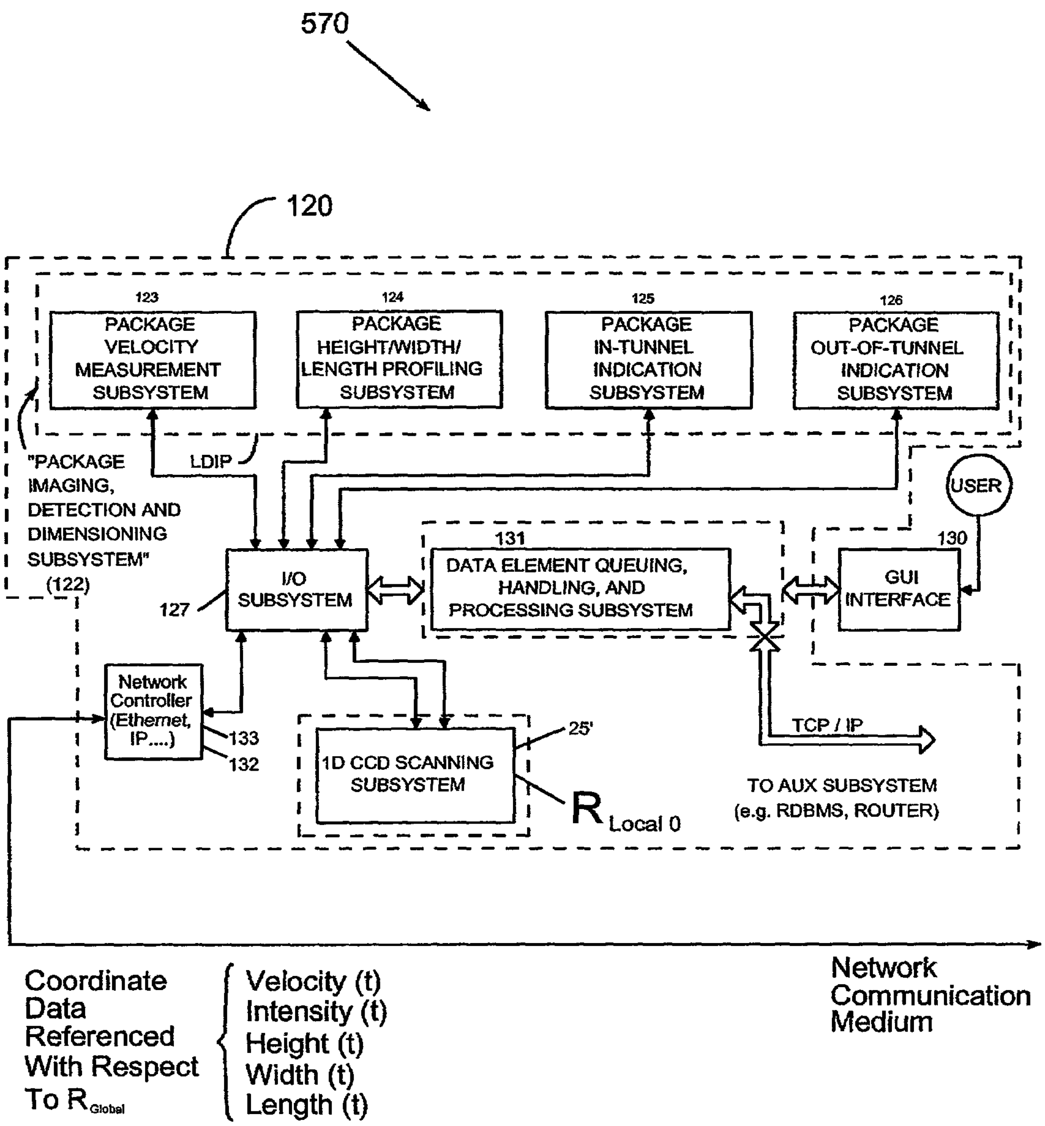


FIG. 84B



570
120
123
PACKAGE VELOCITY MEASUREMENT SUBSYSTEM
124
PACKAGE HEIGHT/WIDTH/ LENGTH PROFILING SUBSYSTEM
125
PACKAGE IN-TUNNEL INDICATION SUBSYSTEM
126
PACKAGE OUT-OF-TUNNEL INDICATION SUBSYSTEM
LDIP
"PACKAGE IMAGING, DETECTION AND DIMENSIONING SUBSYSTEM" (122)
USER
131
130
127
I/O SUBSYSTEM
DATA ELEMENT QUEUING, HANDLING, AND PROCESSING SUBSYSTEM
GUI INTERFACE
Network Controller (Ethernet, IP....)
133
132
25'
1D CCD SCANNING SUBSYSTEM
R Local 0
TCP / IP
TO AUX SUBSYSTEM (e.g. RDBMS, ROUTER)
Coordinate Data Referenced With Respect To R Global
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
Network Communication Medium

FIG. 30-1

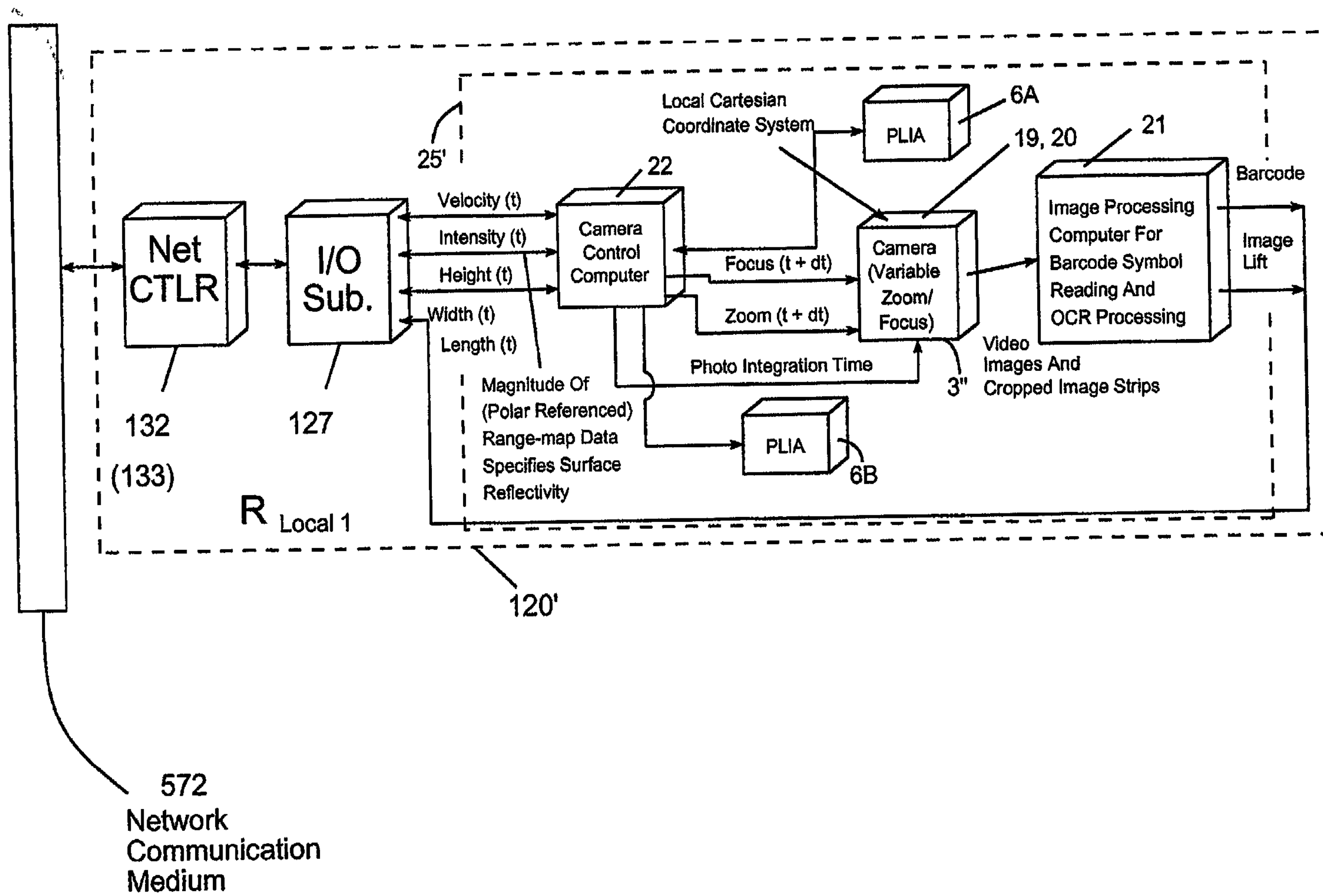

Net CTLR
132
(133)
I/O Sub.
127
R Local 1
120'
25'
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
Magnitude Of (Polar Referenced) Range-map Data Specifies Surface Reflectivity
Camera Control Computer
22
Local Cartesian Coordinate System
PLIA
6A
Focus (t + dt)
Zoom (t + dt)
Photo Integration Time
PLIA
6B
Camera (Variable Zoom/ Focus)
19, 20
3"
Video Images And Cropped Image Strips
Image Processing Computer For Barcode Symbol Reading And OCR Processing
21
Barcode
Image Lift
572
Network Communication Medium

FIG. 30-2

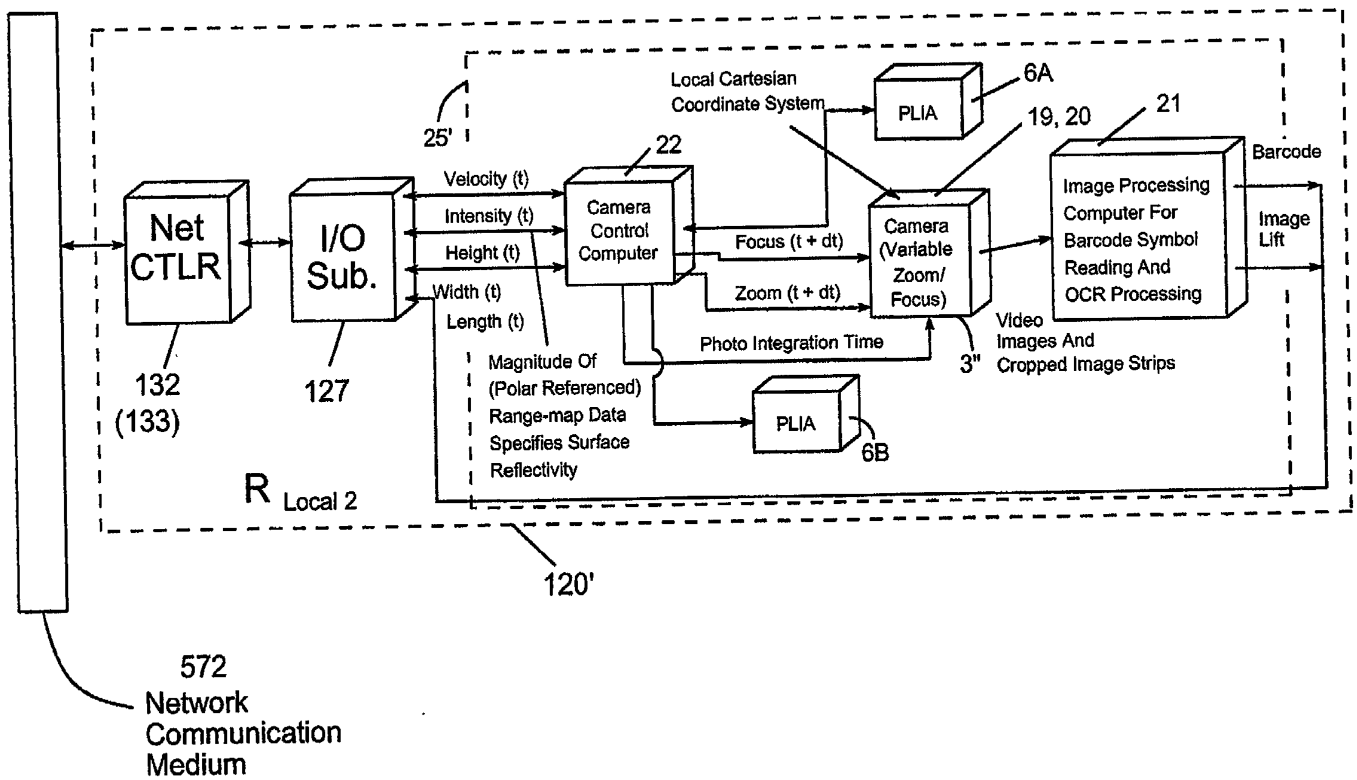

Net CTLR
132 (133)
I/O Sub.
127
R Local 2
120'
25'
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
Magnitude Of (Polar Referenced) Range-map Data Specifies Surface Reflectivity
Camera Control Computer
22
Local Cartesian Coordinate System
PLIA
6A
19, 20
Focus (t + dt)
Zoom (t + dt)
Camera (Variable Zoom/ Focus)
3"
Photo Integration Time
PLIA
6B
21
Image Processing Computer For Barcode Symbol Reading And OCR Processing
Video Images And Cropped Image Strips
Barcode
Image Lift
572 Network Communication Medium

FIG. 30-3

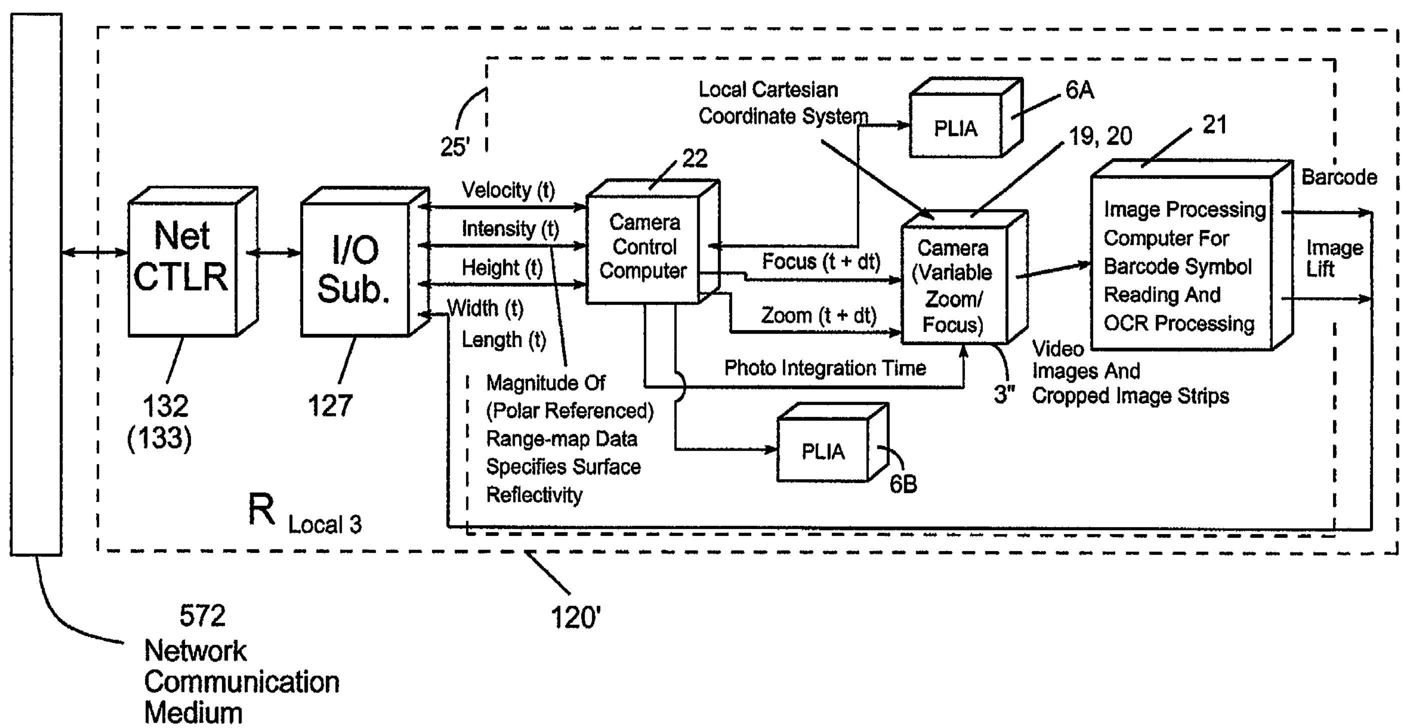

Net CTLR
I/O Sub.
132
(133)
127
R Local 3
25'
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
Magnitude Of
(Polar Referenced)
Range-map Data
Specifies Surface
Reflectivity
22
Camera
Control
Computer
Local Cartesian
Coordinate System
PLIA
6A
PLIA
6B
19, 20
Focus (t + dt)
Zoom (t + dt)
Photo Integration Time
Camera
(Variable
Zoom/
Focus)
3"
Video
Images And
Cropped Image Strips
21
Image Processing
Computer For
Barcode Symbol
Reading And
OCR Processing
Barcode
Image
Lift
120'
572
Network
Communication
Medium

FIG. 30-4

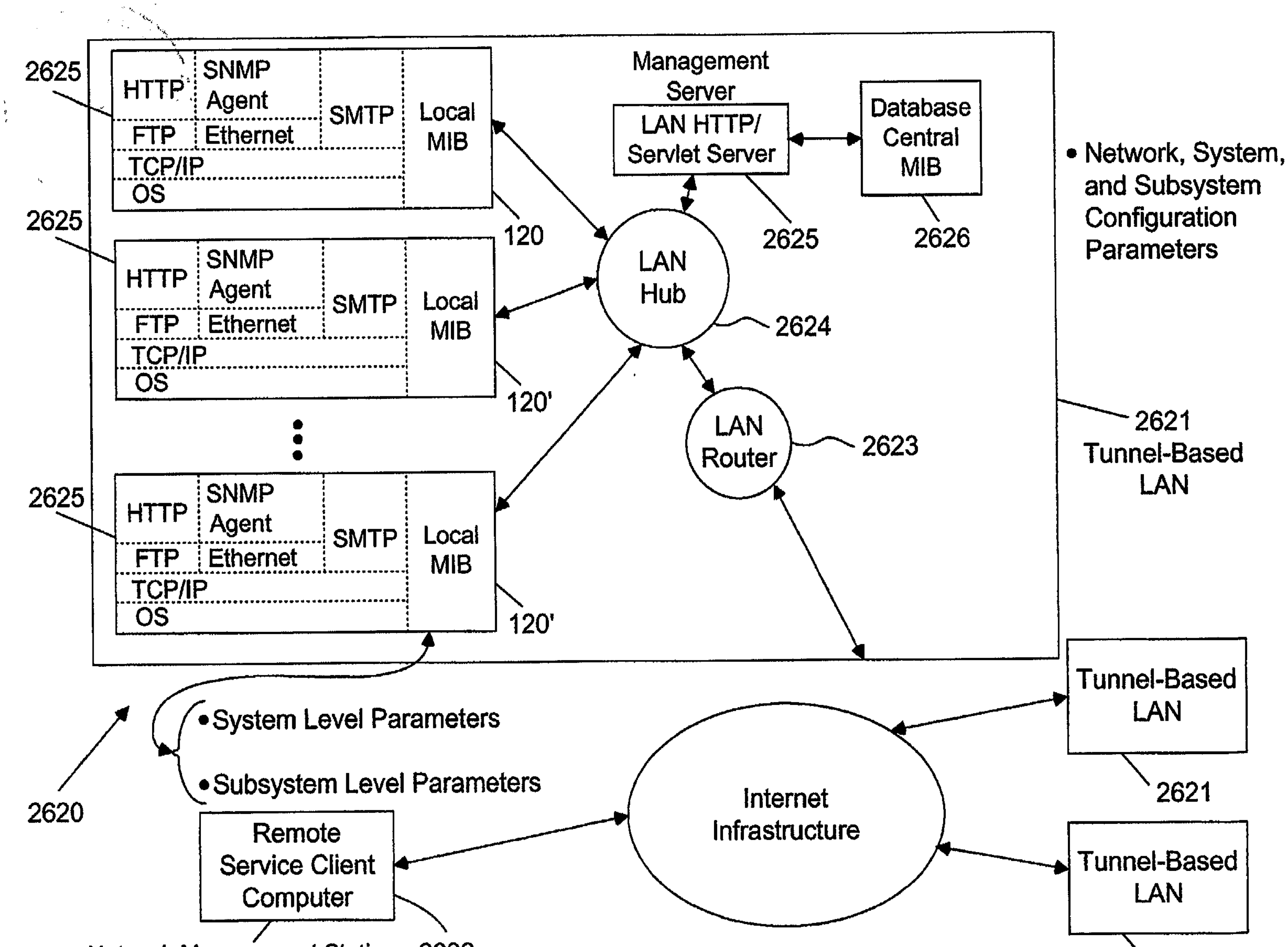

2625
HTTP
SNMP Agent
FTP
Ethernet
SMTP
TCP/IP
OS
Local MIB
120
2625
HTTP
SNMP Agent
FTP
Ethernet
SMTP
TCP/IP
OS
Local MIB
120'
2625
HTTP
SNMP Agent
FTP
Ethernet
SMTP
TCP/IP
OS
Local MIB
120'
Management Server
LAN HTTP/ Servlet Server
2625
Database Central MIB
2626
LAN Hub
2624
LAN Router
2623
• Network, System, and Subsystem Configuration Parameters
2621 Tunnel-Based LAN
• System Level Parameters
• Subsystem Level Parameters
2620
Remote Service Client Computer
Network Management Station (NMS), i.e. management console
2622
Internet Infrastructure
Tunnel-Based LAN
2621
Tunnel-Based LAN
2621

FIG. 30A

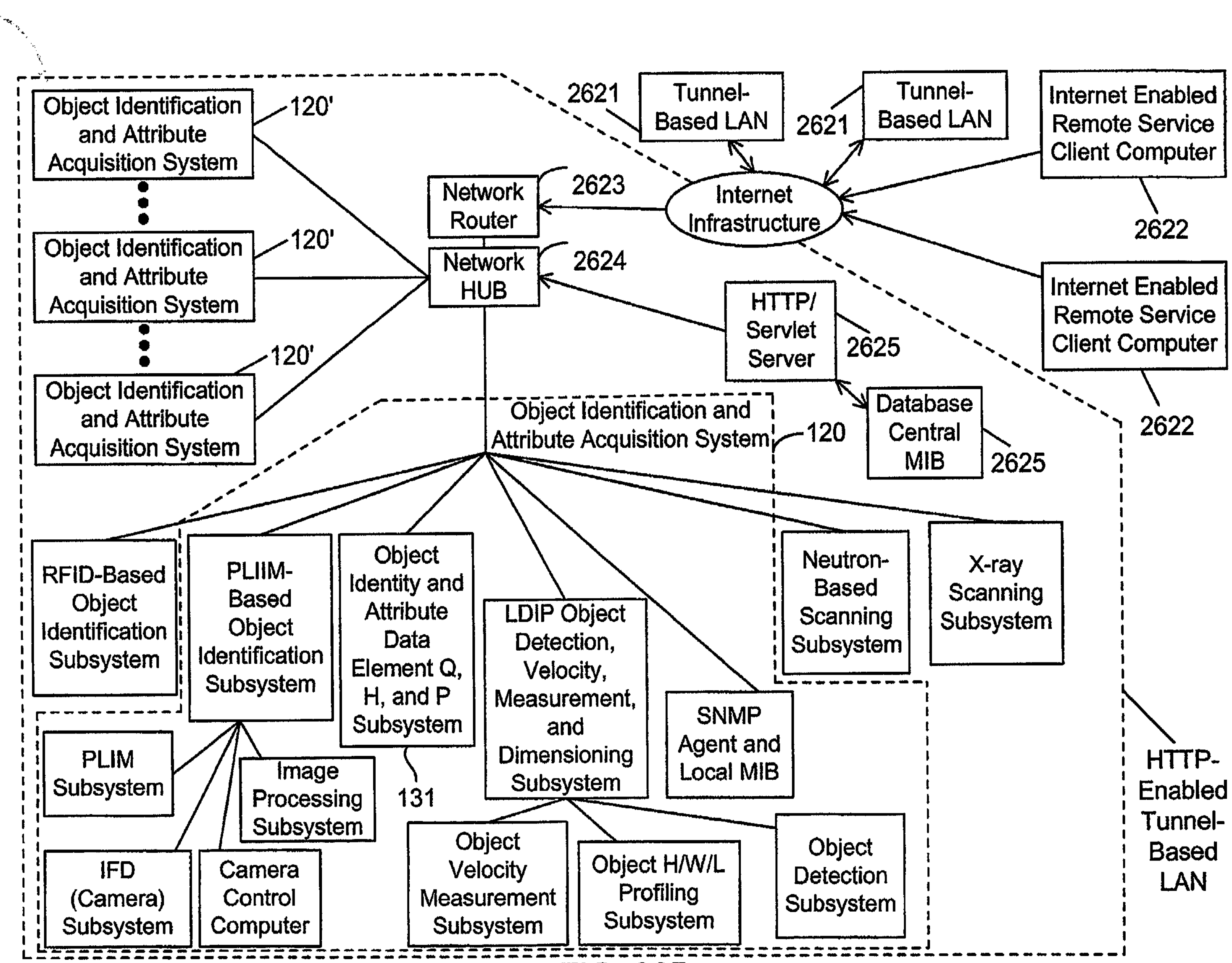

Object Identification and Attribute Acquisition System
120'
Object Identification and Attribute Acquisition System
120'
Object Identification and Attribute Acquisition System
120'
Network Router
2623
Network HUB
2624
2621
Tunnel-Based LAN
2621
Tunnel-Based LAN
Internet Infrastructure
Internet Enabled Remote Service Client Computer
2622
Internet Enabled Remote Service Client Computer
2622
HTTP/ Servlet Server
2625
Database Central MIB
2625
Object Identification and Attribute Acquisition System
120
RFID-Based Object Identification Subsystem
PLIIM-Based Object Identification Subsystem
Object Identity and Attribute Data Element Q, H, and P Subsystem
131
LDIP Object Detection, Velocity, Measurement, and Dimensioning Subsystem
SNMP Agent and Local MIB
Neutron-Based Scanning Subsystem
X-ray Scanning Subsystem
PLIM Subsystem
Image Processing Subsystem
IFD (Camera) Subsystem
Camera Control Computer
Object Velocity Measurement Subsystem
Object H/W/L Profiling Subsystem
Object Detection Subsystem
HTTP-Enabled Tunnel-Based LAN

FIG. 30B

Network Configuration Parameters:

[Router IP address; no. of nodes (i.e. systems) in LAN; passwords, LAN location; name of customer facility; technical contact; phone no.; domain name; object identity codes; object attribute acquisition codes;.....]

System Configuration Parameters:

[System IP Address; passwords; object identity codes; object attribute acquisition codes;....]

Monitorable and/or Configurable Parameters for Subsystems Within Each System:

These subsystems generate object identity parameters

- PLIIM-based object identification subsystem: [object identity code; object attribute acquisition codes;....]
  - PLIM Subsystem: [VLD status; power VLD; TIM function; temp.;....]
  - IFD (Camera) Subsystem: [sensor temp; .....]
  - Image Processing Subsystem (Computer): [processor load history; system up time; # of frames (pgs); barcode read rate; current line rate;....]
  - Camera Contact Subsystem (Computer): [number of frames dropped; number of focused zoom commands; number and kinds of motor control errors;....]
- RFID-based object identification subsystem: [....]

This system links object attribute data element parameters(i.e. object identity data element) to corresponding object identity parameters (i.e. object atrribute data element)

- Object identity and attribute data element queuing, handling and processing subsystem: [....]

These subsystems generate object attribute parameters

- LDIP object identification, velocity-measurement, and dimensioning subsystem: [....]
  - Object velocity measurement subsystem: [polygon RPM; polygon laser output X; channel X drift; channel X noise; trigger error events; instant lock reference drift; temperature]
  - Object H/W/L profiling subsystem
  - Object detection subsystem: [non- singulation/ singulation code;....]
- X-ray scanning subsystem: [....]
- Neutron-beam scanning subsystem: [....]

FIG. 30C

A: Use an Internet-enabled client computer to establish a network connection (via network router) with an HTTP server in the tunnel-based LAN requiring remote monitoring, control and/or service.

B: Use an Internet-enabled client computer to access an RMCS management console (GUI) from the HTTP server and display the same.

C: Use the RMCS management console to display network configuration parameters in the tunnel-based LAN, and to use these network configuration parameters to monitor configuration parameters and performance parameters of each system in the network.

D: Use the RMCS management console to monitor the configuration and other monitorable parameters of each subsystem in the system.

E: Use the RMCS management console to run a diagnostic program to trouble shoot any performance problems with the system.

F: Using information collected by the diagnostic program and the RCMS management console, reconfigure selected parameters in the system and instruct any hardware repairs that may be required at the LAN location.

A

FIG. 30D1

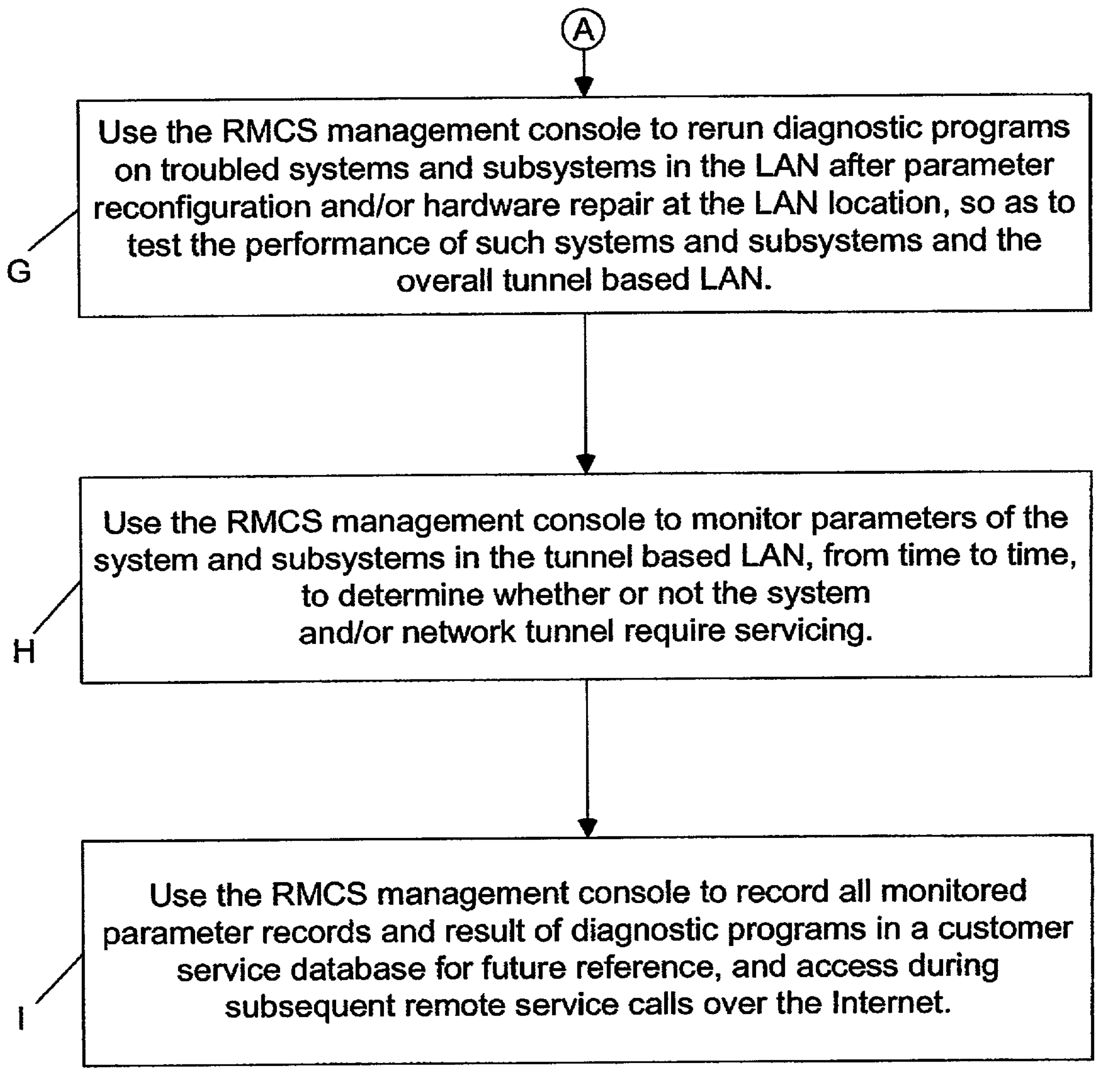
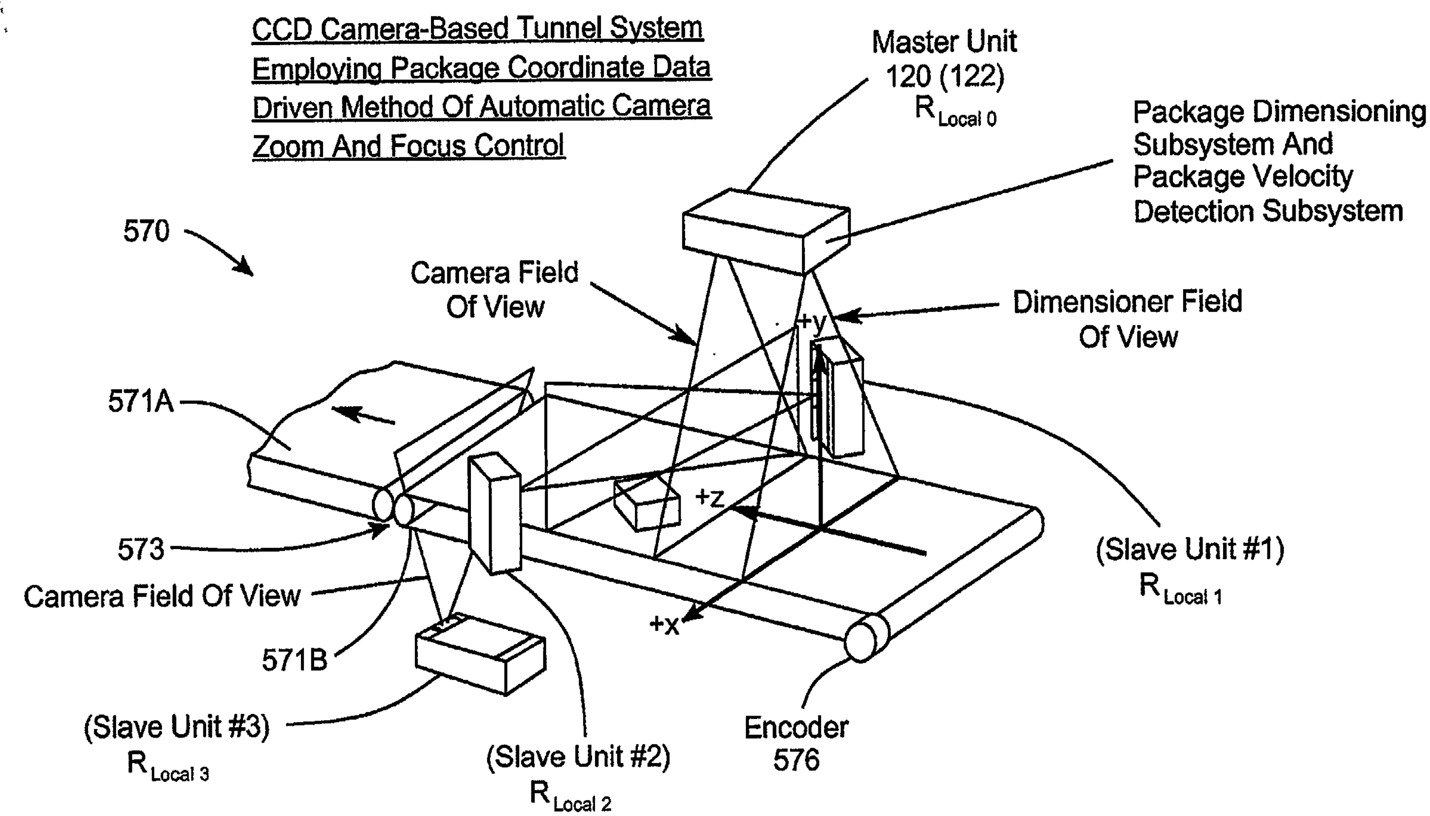

A
Use the RMCS management console to rerun diagnostic programs on troubled systems and subsystems in the LAN after parameter reconfiguration and/or hardware repair at the LAN location, so as to test the performance of such systems and subsystems and the overall tunnel based LAN.
G
Use the RMCS management console to monitor parameters of the system and subsystems in the tunnel based LAN, from time to time, to determine whether or not the system and/or network tunnel require servicing.
H
Use the RMCS management console to record all monitored parameter records and result of diagnostic programs in a customer service database for future reference, and access during subsequent remote service calls over the Internet.
I

FIG. 30D2



$$\text{Package Coordinate Data}\|_{R_{Global}} \xrightarrow{HG} \text{Package Coordinate Data}\|_{R_{Local\ i}}$$

FIG. 31

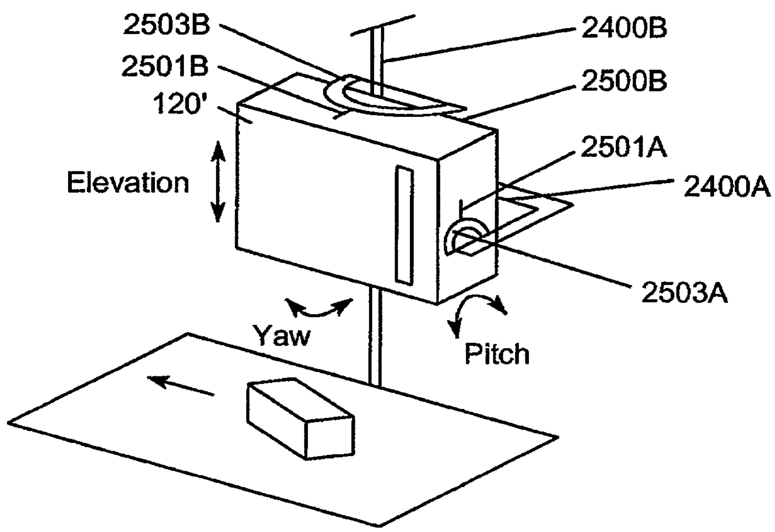

2503B
2501B
120'
2400B
2500B
2501A
2400A
Elevation
2503A
Yaw
Pitch

FIG. 31A

A: For each package transported through tunnel system, the master unit (with package dimensioning subsystem and velocity detection subsystem) generates package height, width, length and velocity data $(H, W, L, V)_G$, referenced with respect to global coordinate reference system R_{Global} and transmits such package dimension data to each slave unit downstream, using the systems data communication network.

↓

B: Each slave unit receives the transmitted package height, width, and length data $\{H, W, L, V\}_G$ and converts this coordinate information into the slave unit's local coordinate reference system $R_{Local\ I}$, $\{H, W, L, V\}_I$

↓

C: The camera control computer in each slave unit uses the converted package height, width, length data $\{H, W, L\}_i$ and package velocity data to generate camera control signals for driving the camera subsystem in the slave unit to zoom and focus in on the transported package as it moves by the slave unit, while ensuring that captured images having substantially constant O.P.I. Resolution and 1:1 aspect ratio.

↓

(A)

FIG. 32A

A

D — Each slave unit captures images acquired by its intelligently controlled camera subsystem, buffers the same, and processes the images to decode bar code symbol identifiers represented in said images, and/ or to perform optical character recognition (OCR) thereupon.

E — The slave unit which decodes a bar code symbol in a processed image automatically transmits a package identification data element (containing symbol character data representative of the decoded bar code symbol) to the master unit (or other designated system control unit employing data element management functionalities) for package data element processing.

F — Master unit time-stamps received package identification data element, places said data element in a data queue, and processes package identification data elements and time-stamped package dimension data elements in said queue to link each package identification data element with one said corresponding package dimension data element.

FIG. 32B

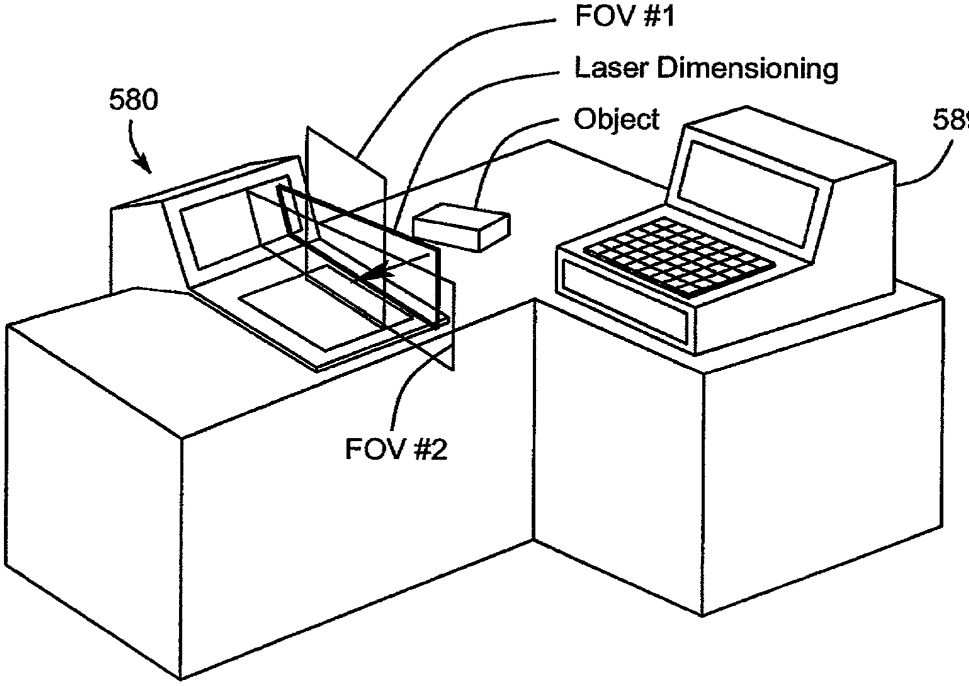


FIG. 33A

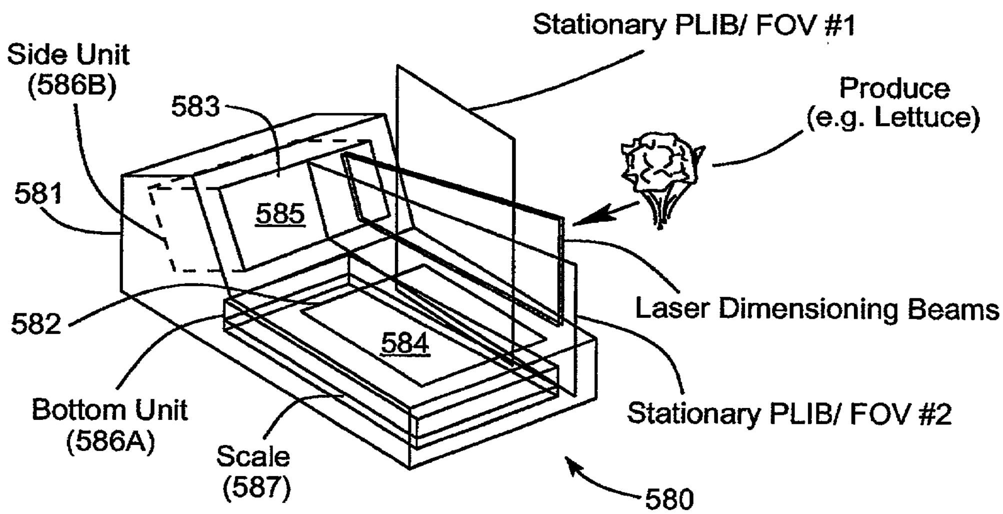


FIG. 33B

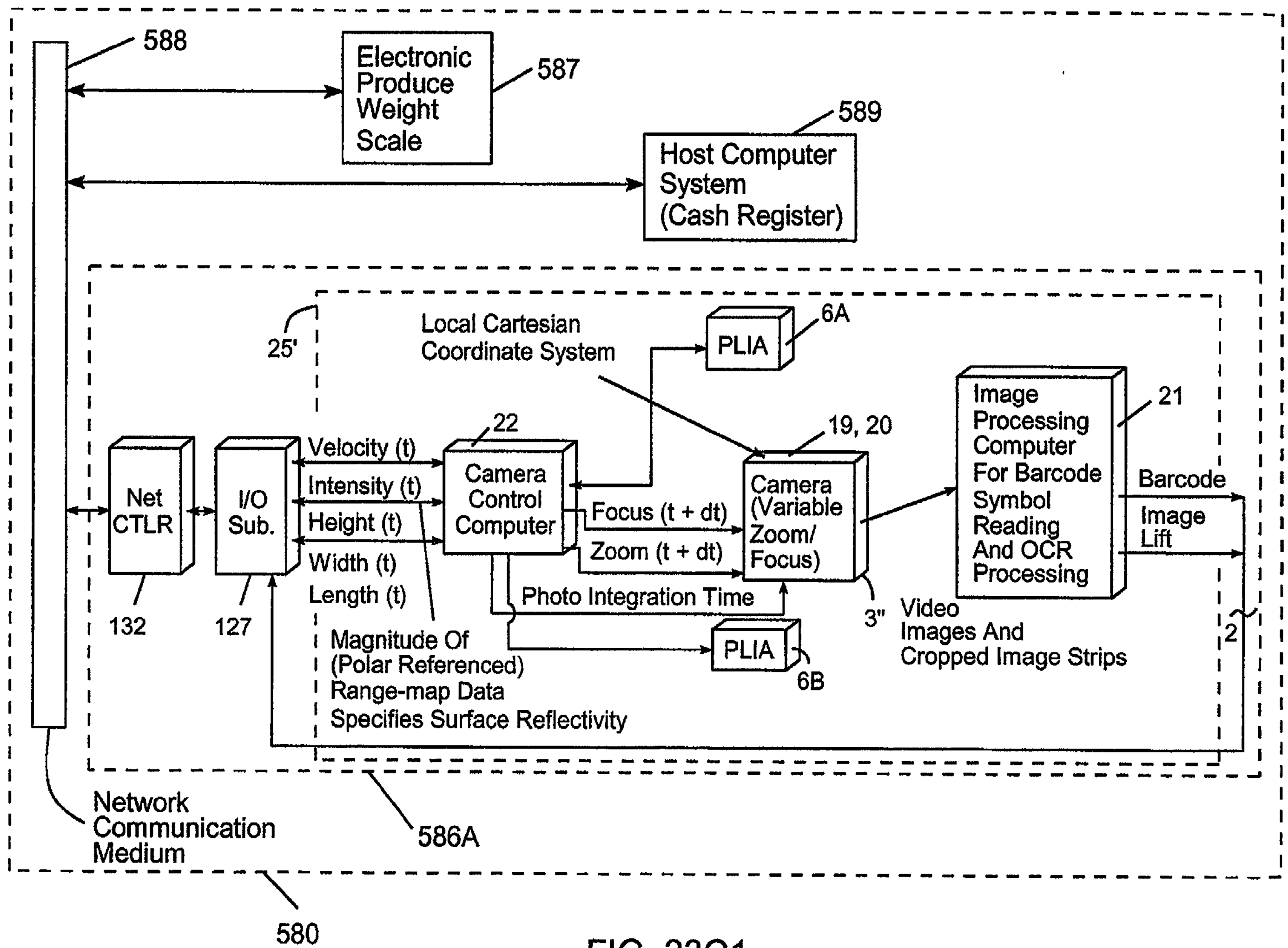

588
Electronic Produce Weight Scale
587
589
Host Computer System (Cash Register)
25'
Local Cartesian Coordinate System
PLIA
6A
Net CTLR
I/O Sub.
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
22
Camera Control Computer
Focus (t + dt)
Zoom (t + dt)
Photo Integration Time
19, 20
Camera (Variable Zoom/ Focus)
Image Processing Computer For Barcode Symbol Reading And OCR Processing
21
Barcode
Image Lift
132
127
Magnitude Of (Polar Referenced) Range-map Data Specifies Surface Reflectivity
PLIA
6B
3"
Video Images And Cropped Image Strips
2
Network Communication Medium
586A
580

FIG. 33C1

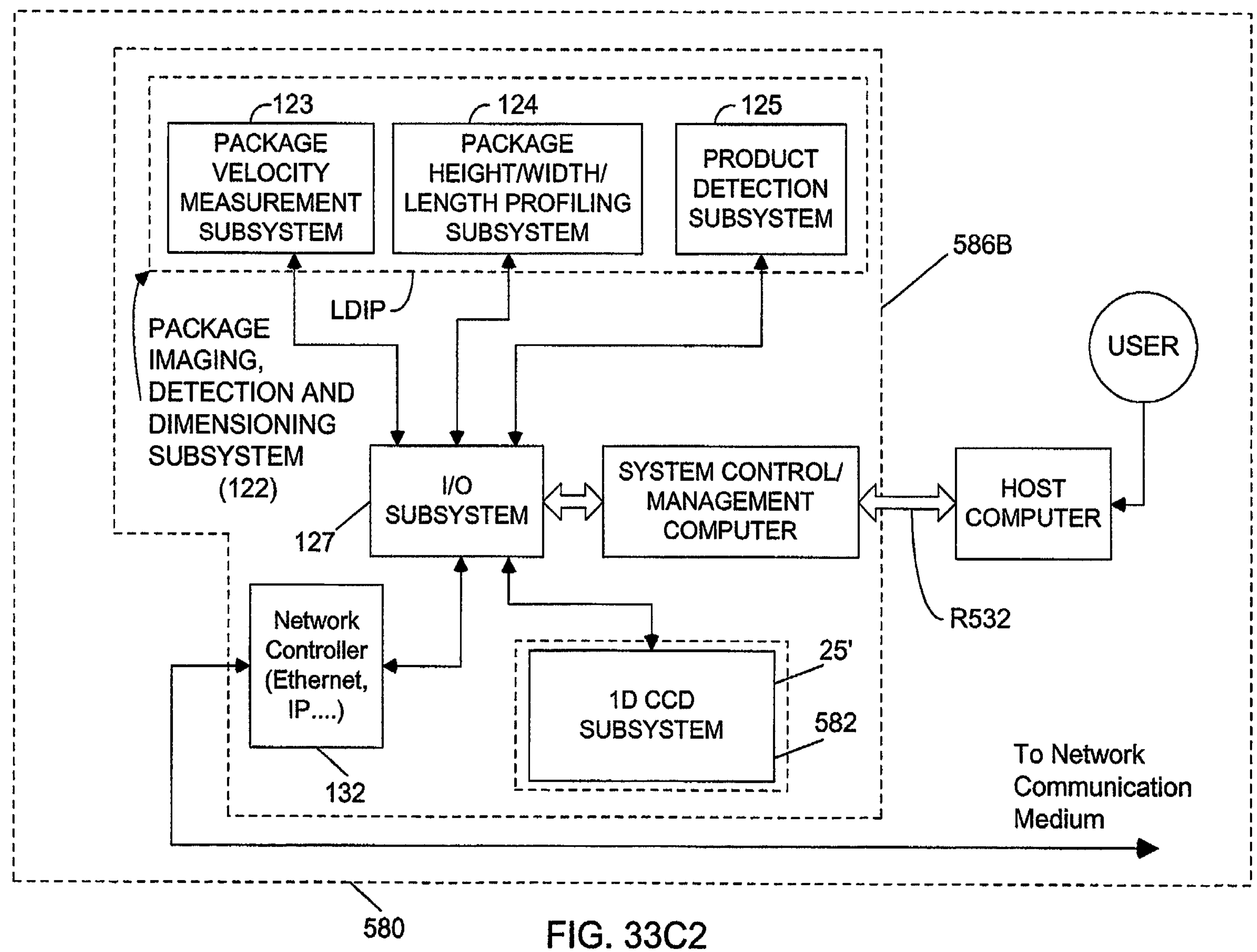

123
PACKAGE VELOCITY MEASUREMENT SUBSYSTEM
124
PACKAGE HEIGHT/WIDTH/ LENGTH PROFILING SUBSYSTEM
125
PRODUCT DETECTION SUBSYSTEM
586B
LDIP
PACKAGE IMAGING, DETECTION AND DIMENSIONING SUBSYSTEM (122)
USER
I/O SUBSYSTEM
SYSTEM CONTROL/ MANAGEMENT COMPUTER
HOST COMPUTER
127
R532
Network Controller (Ethernet, IP....)
25'
1D CCD SUBSYSTEM
582
132
To Network Communication Medium
580

FIG. 33C2

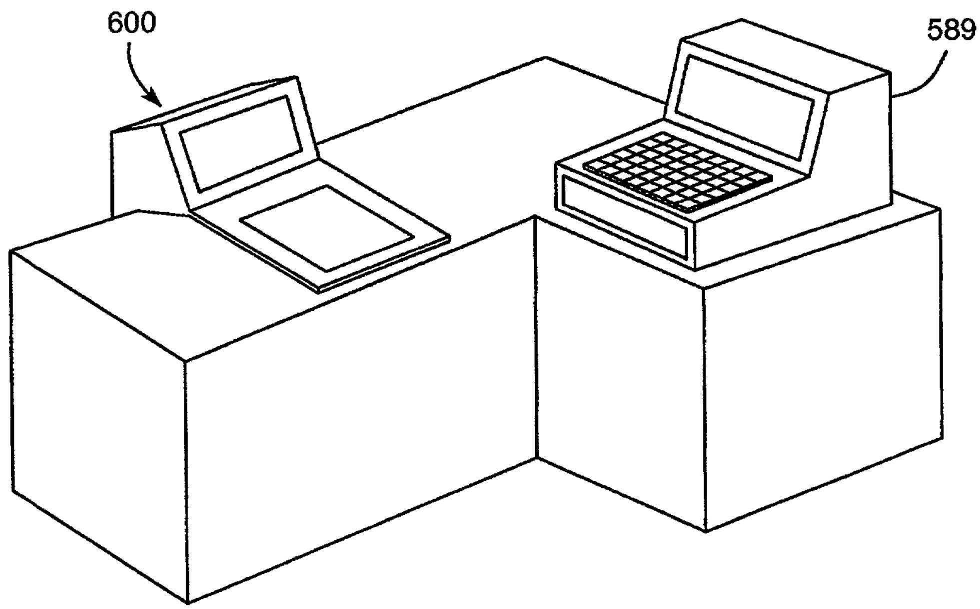


FIG. 34A

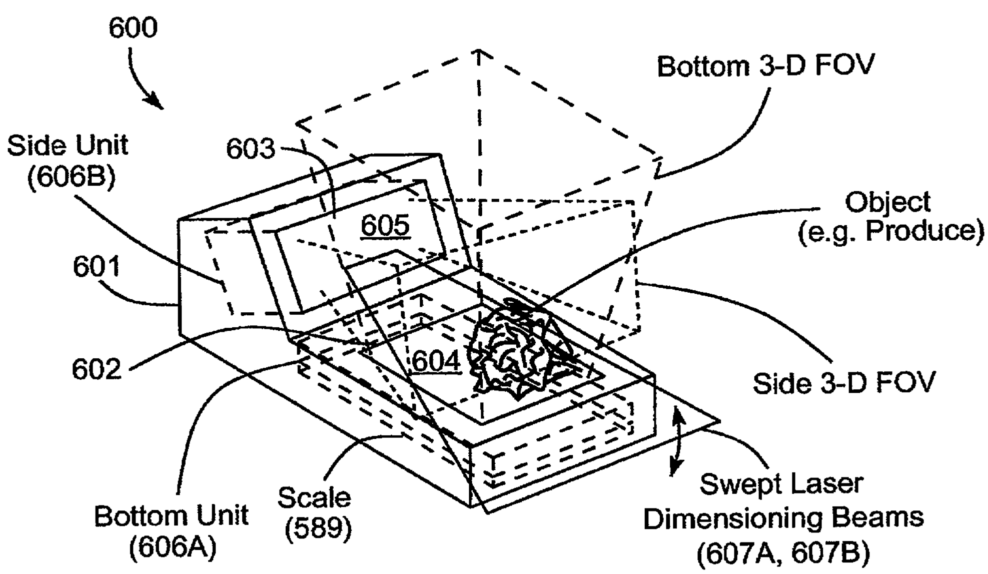


FIG. 34B

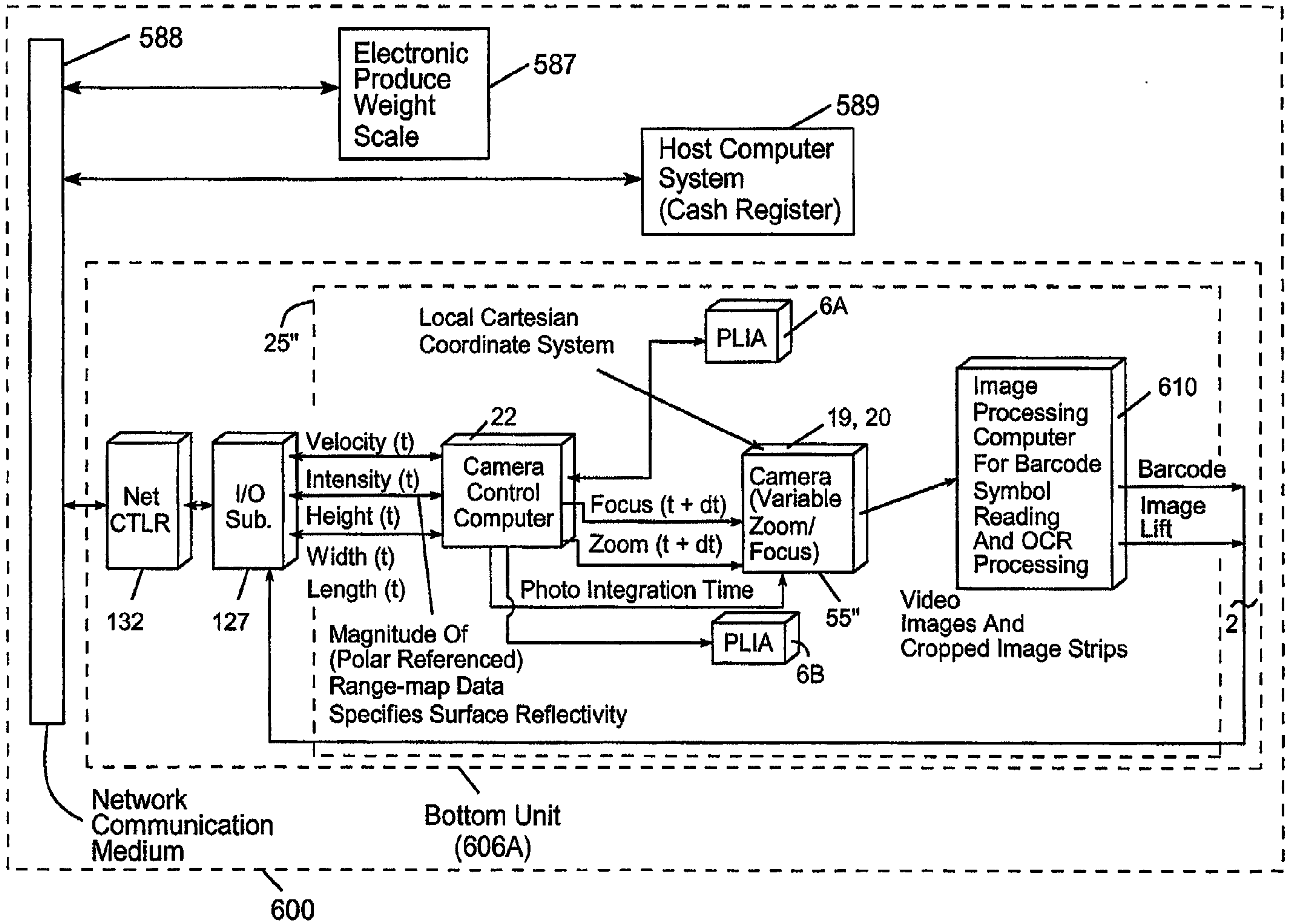

588
Electronic Produce Weight Scale
587
589
Host Computer System (Cash Register)
25"
Local Cartesian Coordinate System
PLIA
6A
610
Image Processing Computer For Barcode Symbol Reading And OCR Processing
22
19, 20
Net CTLR
I/O Sub.
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
Camera Control Computer
Focus (t + dt)
Zoom (t + dt)
Camera (Variable Zoom/ Focus)
Barcode
Image Lift
Photo Integration Time
132
127
55"
Video Images And Cropped Image Strips
2
Magnitude Of (Polar Referenced) Range-map Data Specifies Surface Reflectivity
PLIA
6B
Network Communication Medium
Bottom Unit (606A)
600

FIG. 34C1

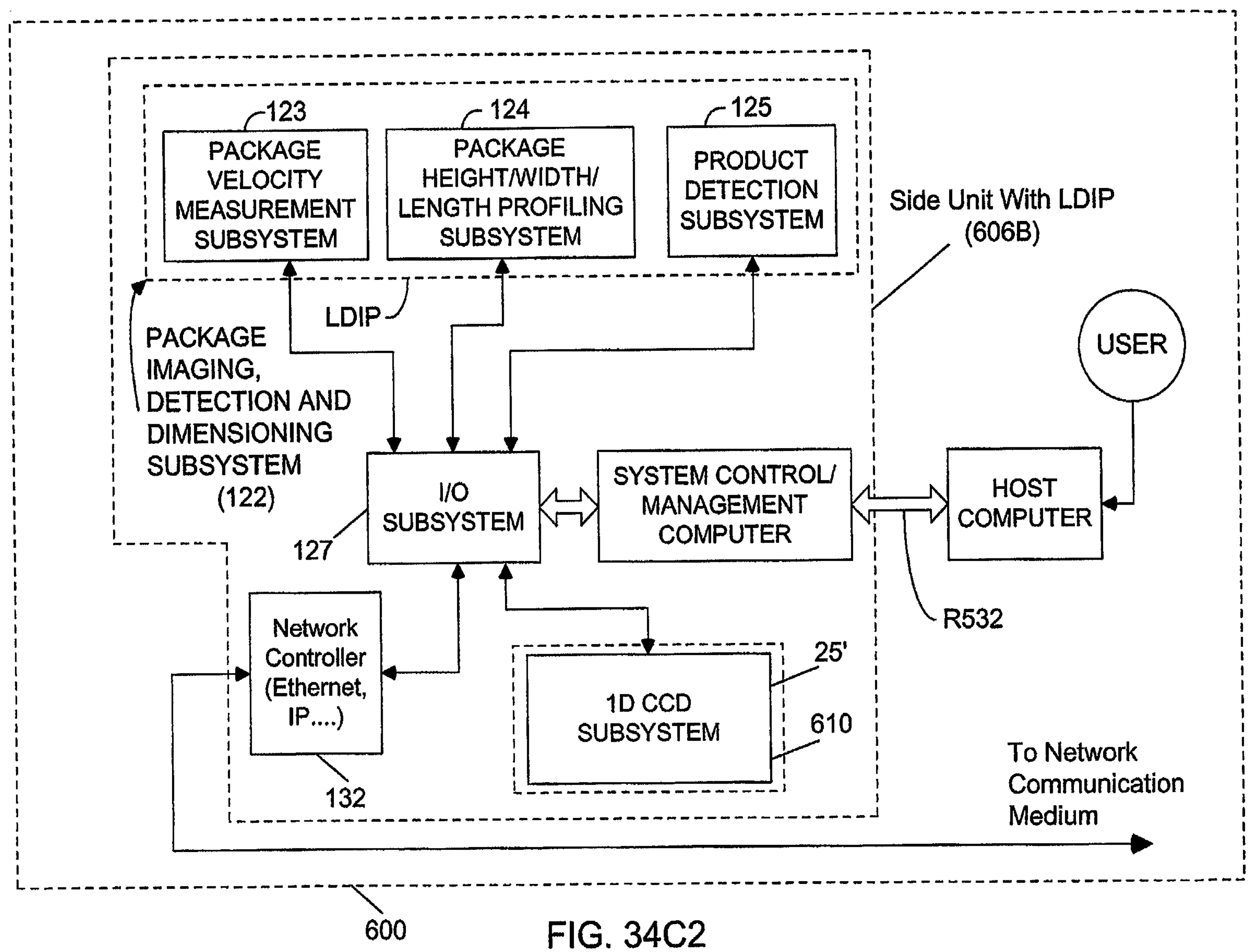

123
PACKAGE VELOCITY MEASUREMENT SUBSYSTEM
124
PACKAGE HEIGHT/WIDTH/ LENGTH PROFILING SUBSYSTEM
125
PRODUCT DETECTION SUBSYSTEM
Side Unit With LDIP (606B)
LDIP
PACKAGE IMAGING, DETECTION AND DIMENSIONING SUBSYSTEM (122)
USER
I/O SUBSYSTEM
SYSTEM CONTROL/ MANAGEMENT COMPUTER
HOST COMPUTER
127
R532
Network Controller (Ethernet, IP....)
25'
1D CCD SUBSYSTEM
610
132
To Network Communication Medium
600

FIG. 34C2

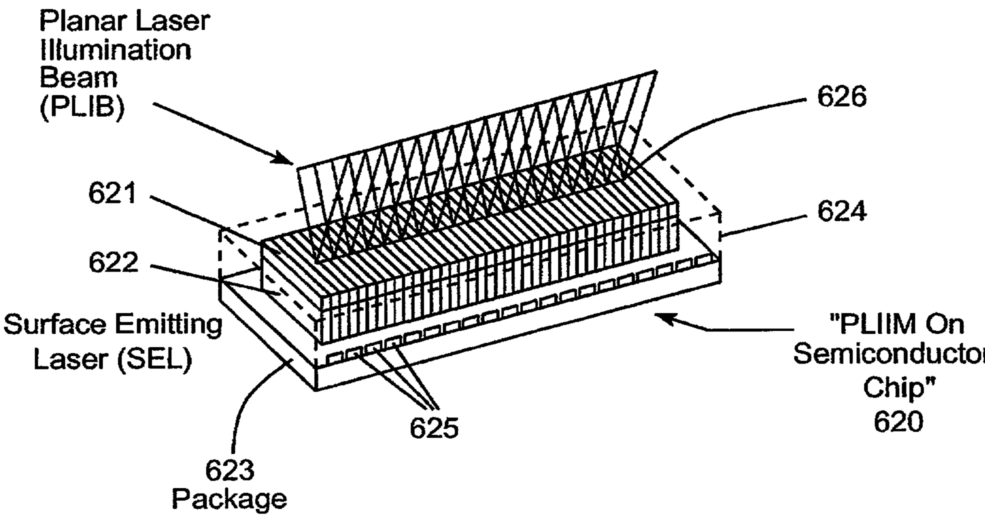


FIG. 35A

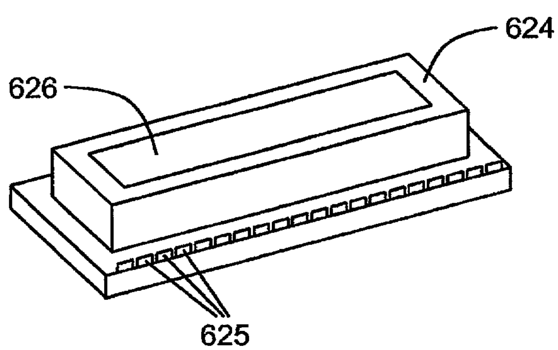


FIG. 35B

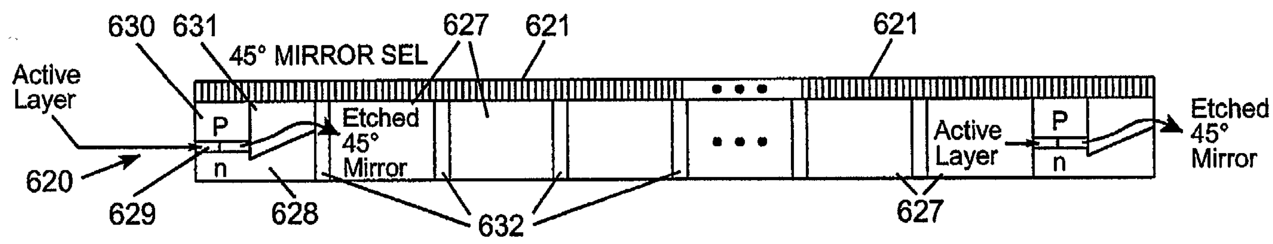


FIG. 36A

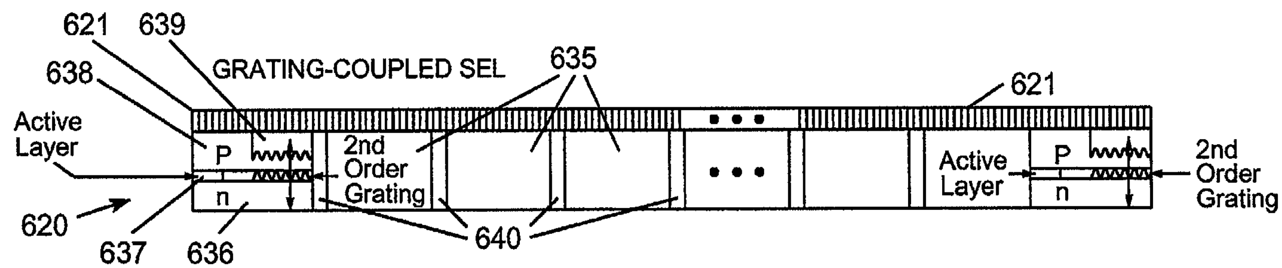


FIG. 36B

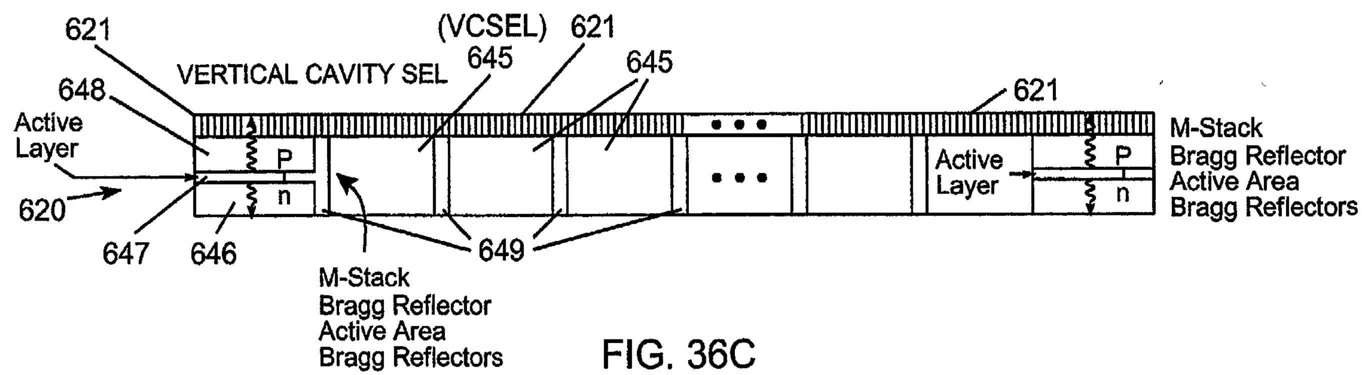


FIG. 36C

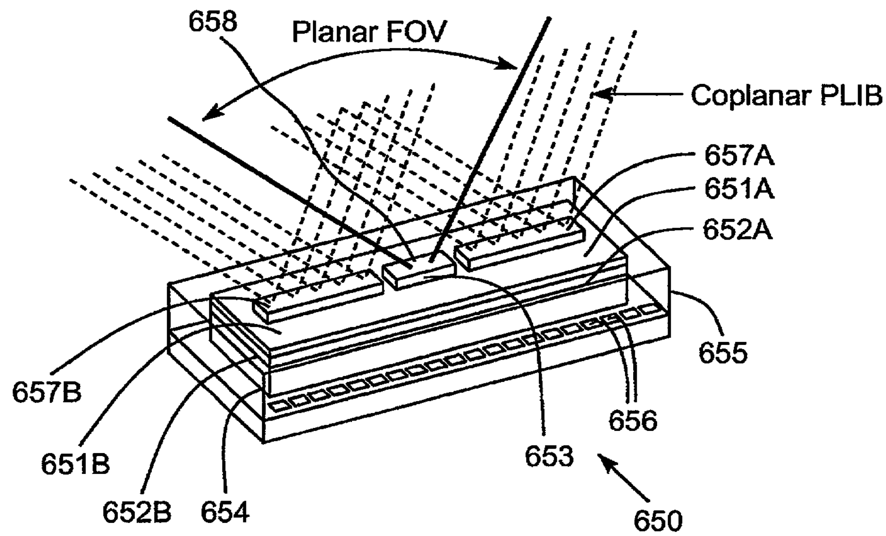

658
Planar FOV
Coplanar PLIB
657A
651A
652A
657B
651B
652B
654
653
656
655
650

FIG. 37

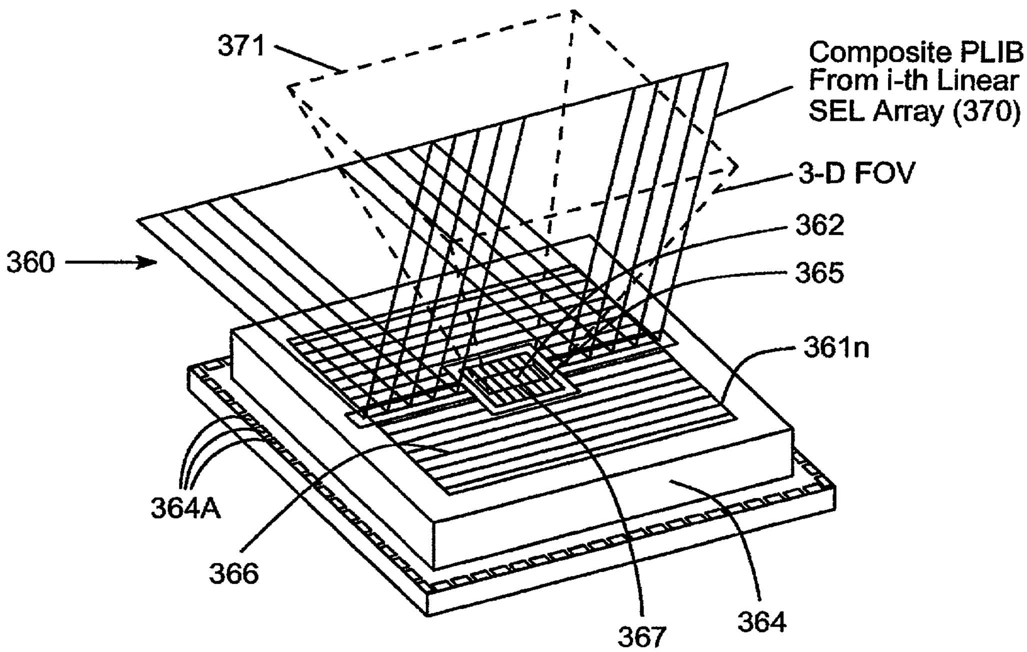


FIG. 38A

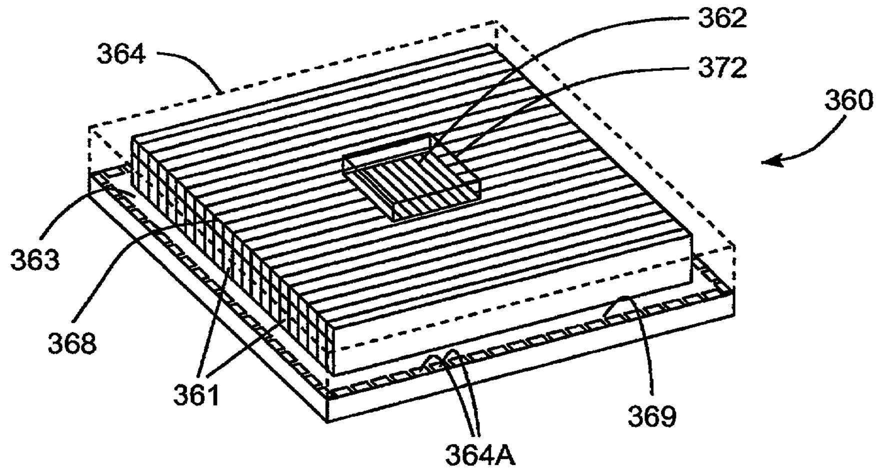


FIG. 38B

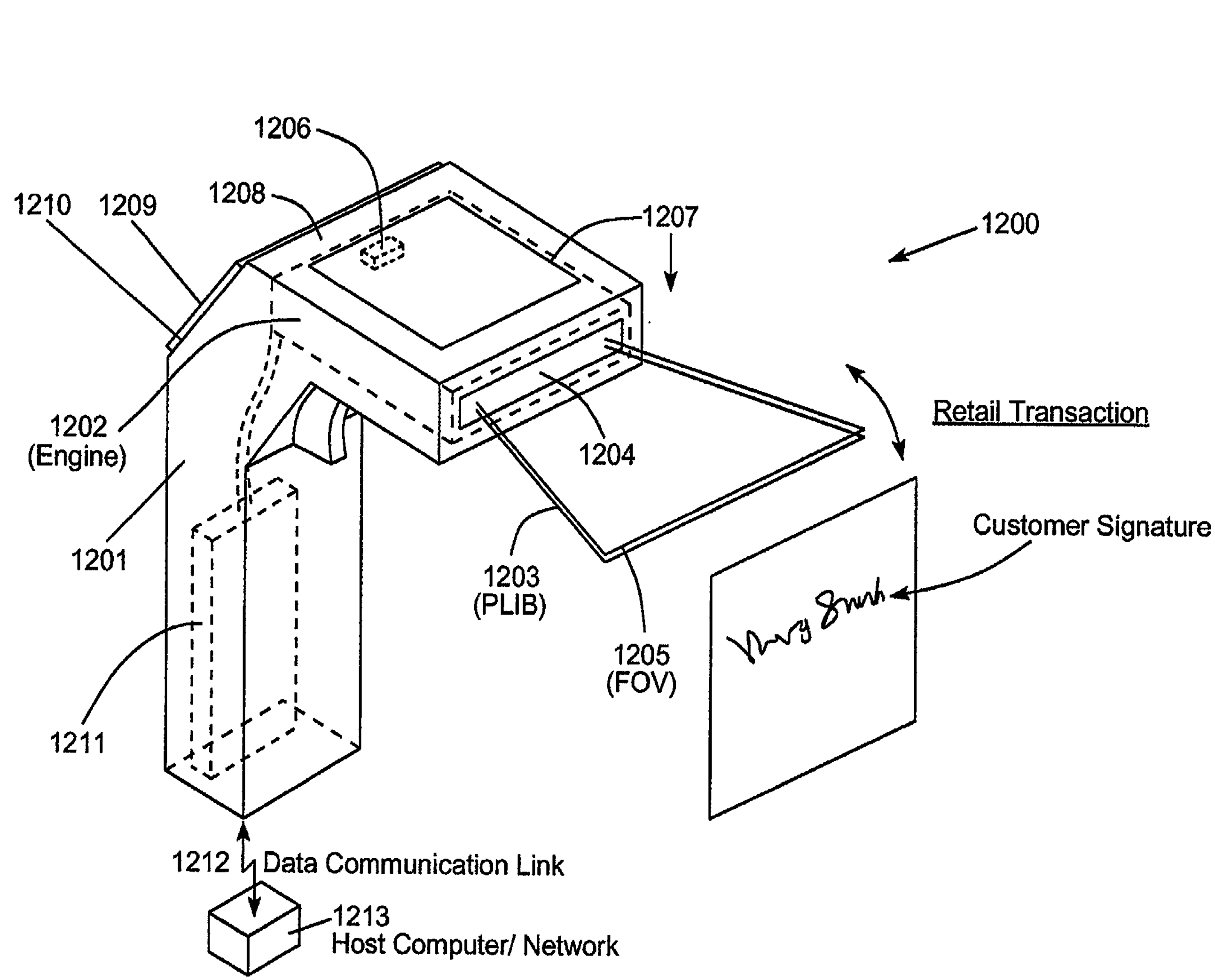

1206
1210
1209
1208
1207
1200
1202
(Engine)
1204
Retail Transaction
1201
Customer Signature
1203
(PLIB)
1205
(FOV)
1211
1212
Data Communication Link
1213
Host Computer/ Network

FIG. 39A

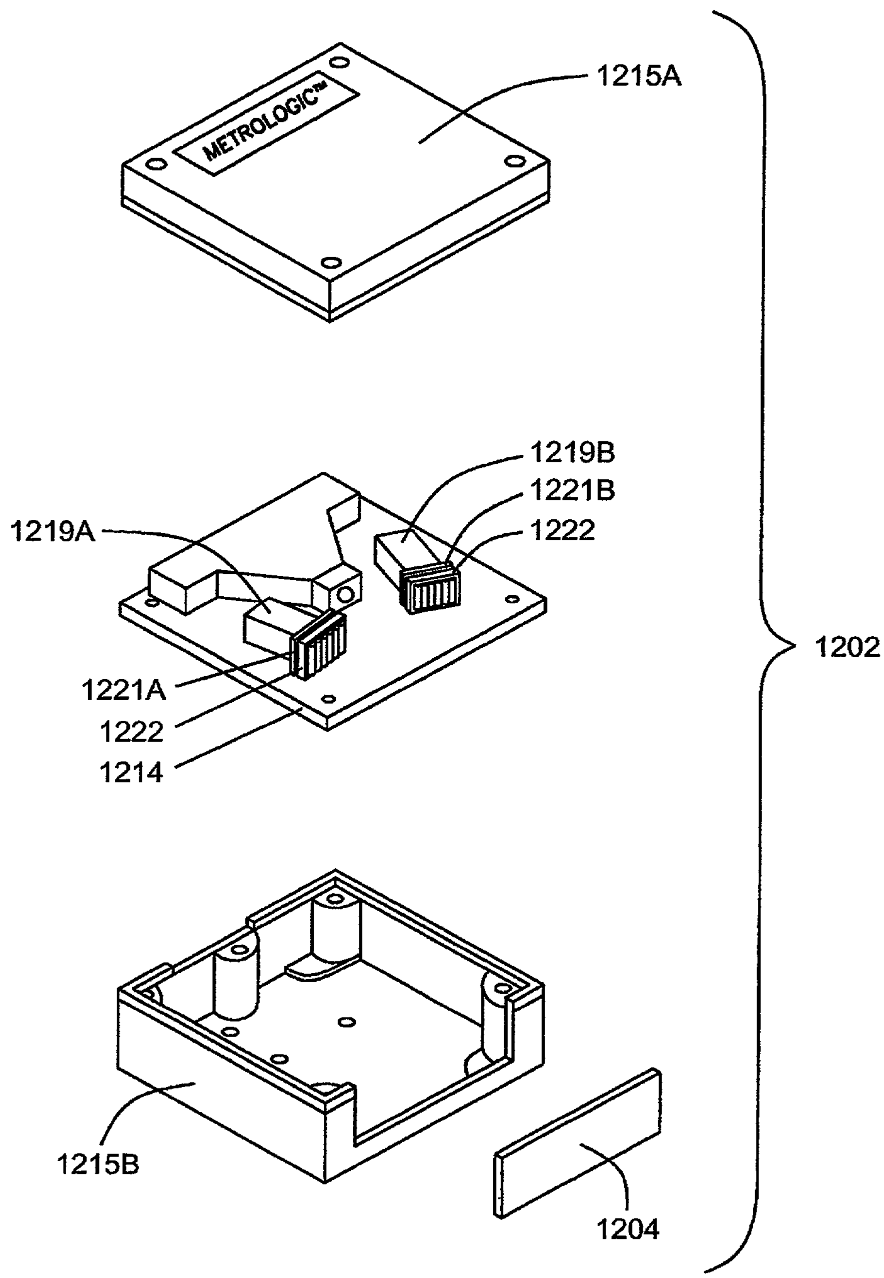

METROLOGIC™
1215A
1219B
1221B
1222
1219A
1202
1221A
1222
1214
1215B
1204

FIG. 39B

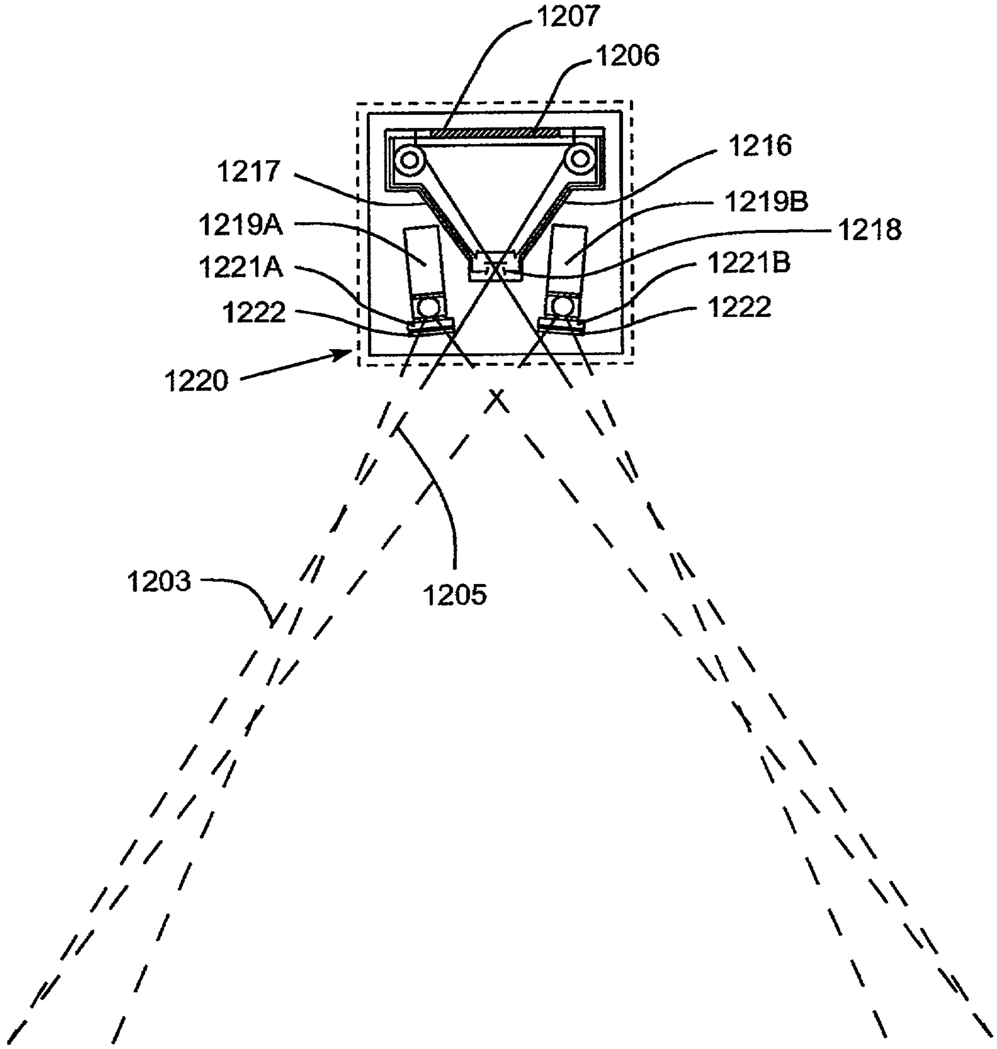

1207
1206
1216
1217
1219B
1219A
1218
1221A
1221B
1222
1222
1220
1203
1205

FIG. 39C

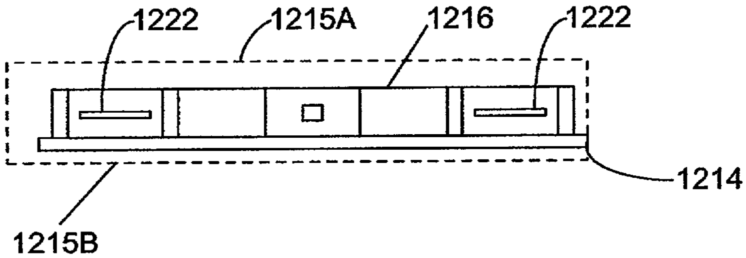


FIG. 39D

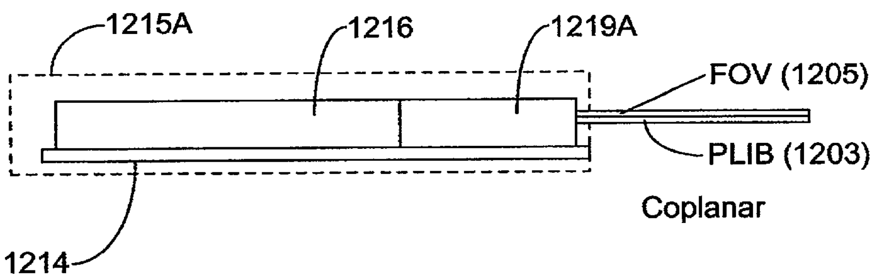


FIG. 39E

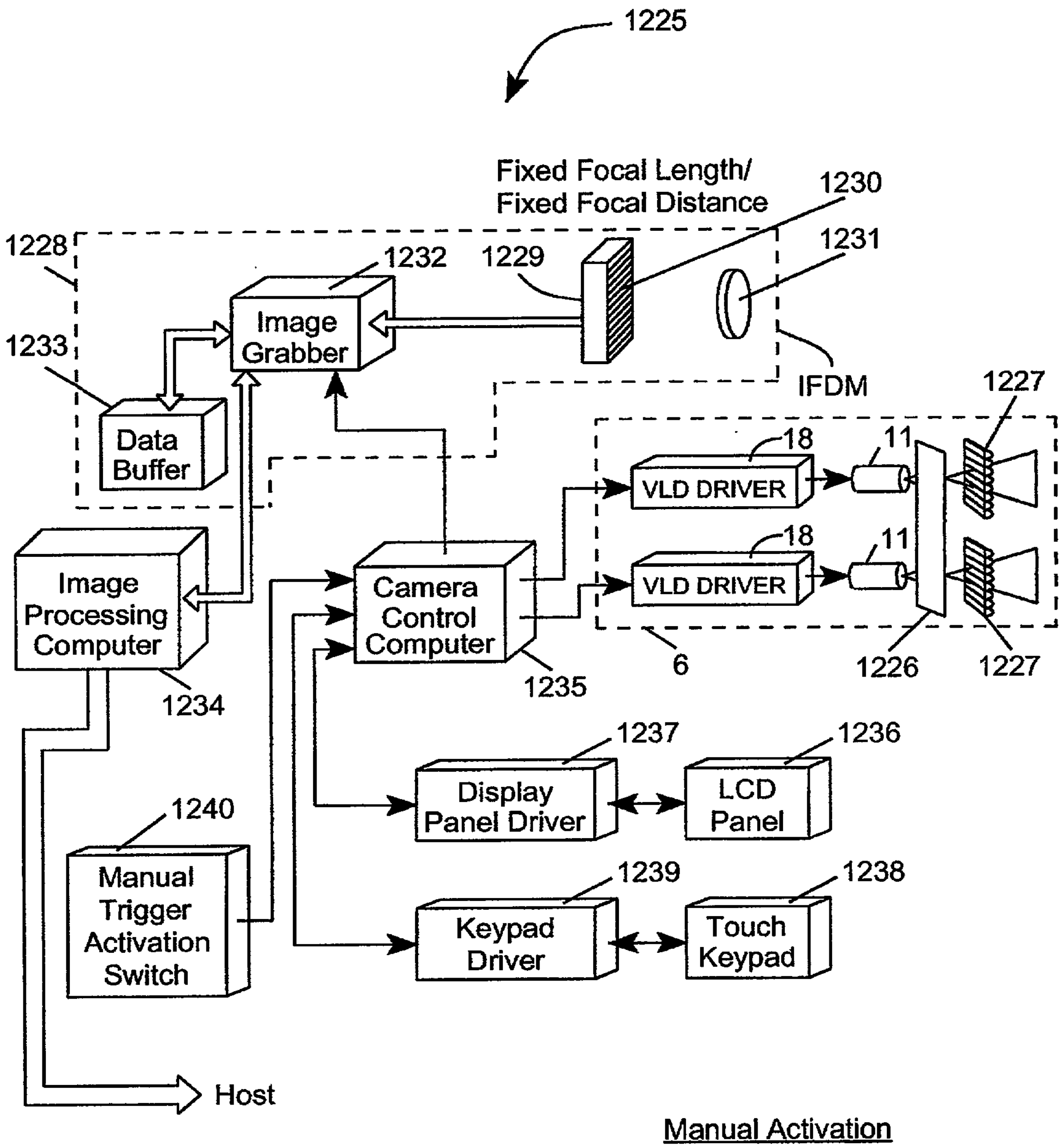

1225
Fixed Focal Length/
Fixed Focal Distance
1230
1231
1228
1232
1229
Image
Grabber
1233
Data
Buffer
IFDM
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
Image
Processing
Computer
Camera
Control
Computer
1234
1235
6
1226
1227
1237
1236
Display
Panel Driver
LCD
Panel
1240
1239
1238
Manual
Trigger
Activation
Switch
Keypad
Driver
Touch
Keypad
Host
Manual Activation

FIG. 40A1

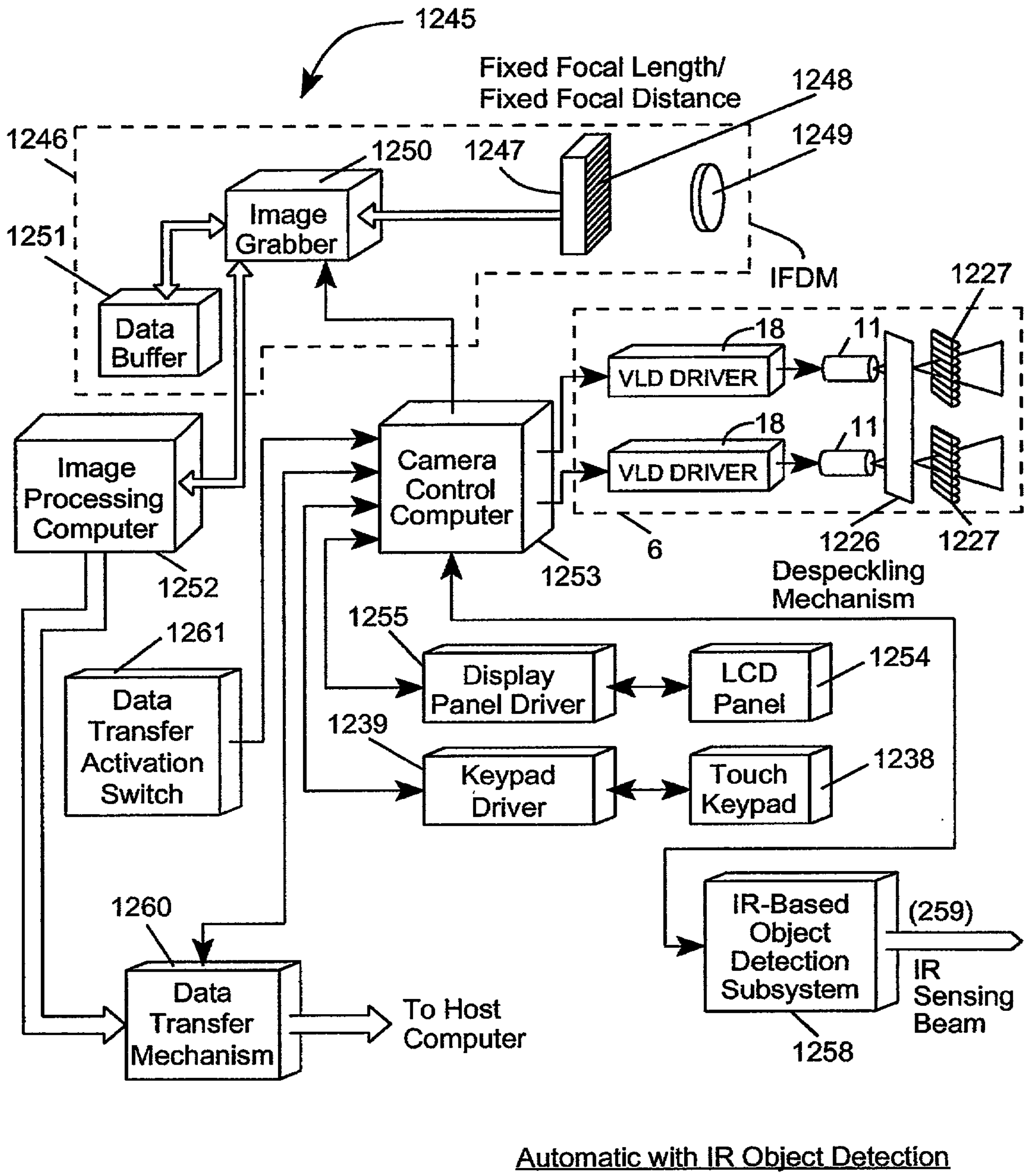

1245
Fixed Focal Length/
Fixed Focal Distance
1248
1249
1246
1250
1247
Image
Grabber
1251
Data
Buffer
IFDM
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
Image
Processing
Computer
Camera
Control
Computer
6
1226
1227
Despeckling
Mechanism
1252
1253
1261
1255
Display
Panel Driver
LCD
Panel
1254
Data
Transfer
Activation
Switch
1239
Keypad
Driver
Touch
Keypad
1238
1260
IR-Based
Object
Detection
Subsystem
(259)
IR
Sensing
Beam
Data
Transfer
Mechanism
To Host
Computer
1258
Automatic with IR Object Detection

FIG. 40A2

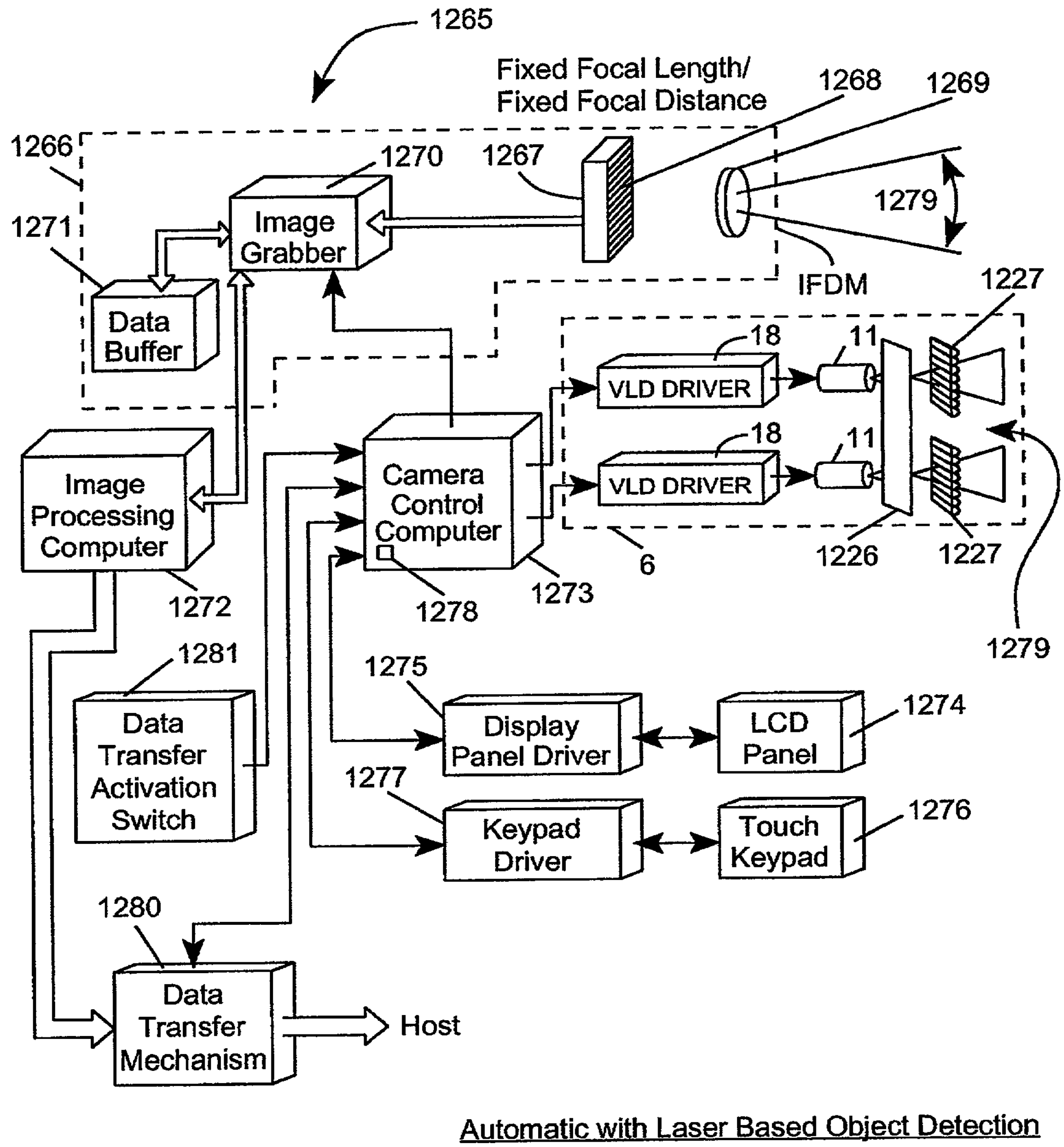
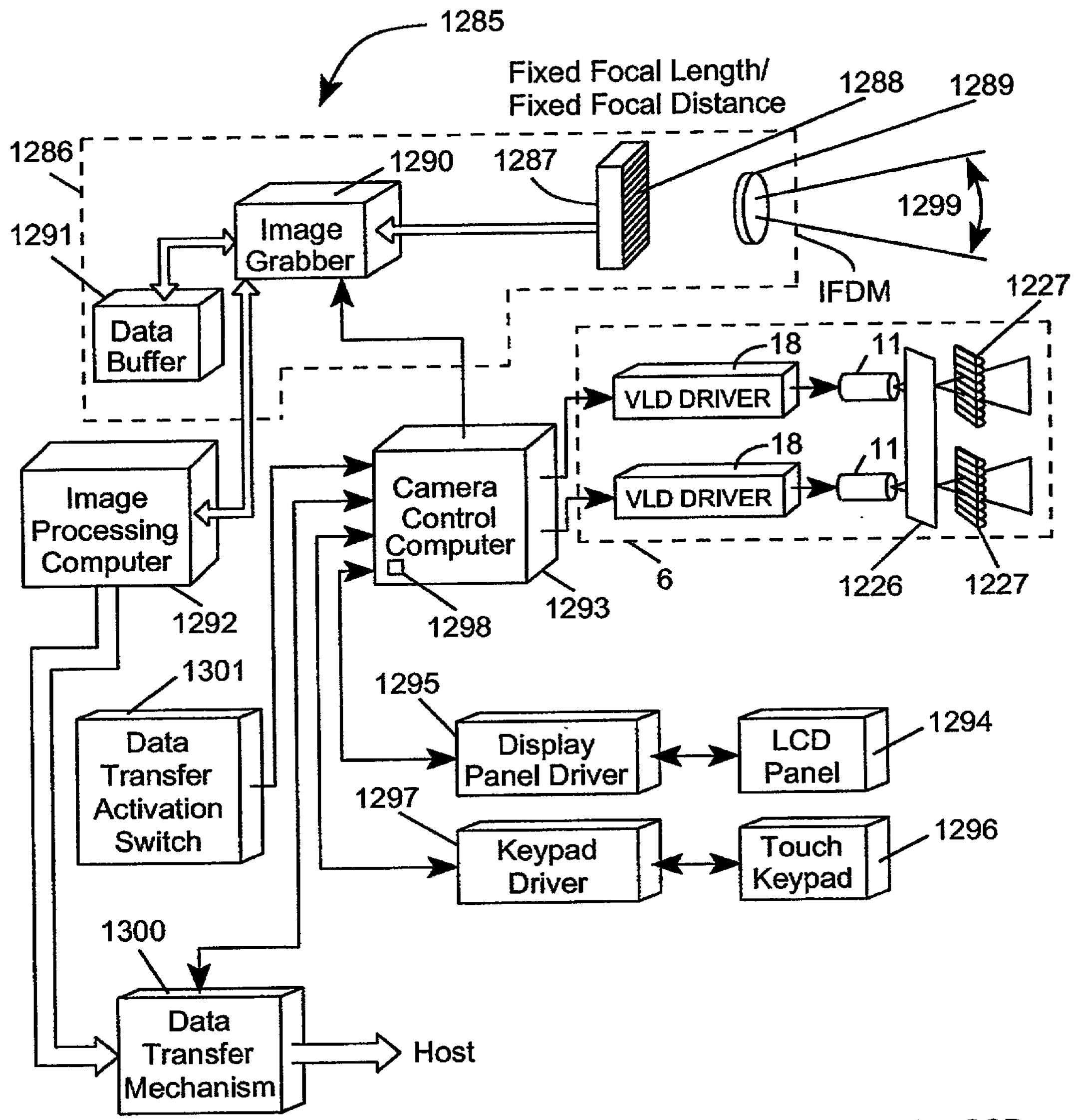

1265
Fixed Focal Length/
Fixed Focal Distance
1268
1269
1266
1270
1267
1279
1271
Image
Grabber
IFDM
1227
Data
Buffer
18
11
VLD DRIVER
18
11
Image
Processing
Computer
Camera
Control
Computer
VLD DRIVER
6
1226
1227
1278
1273
1272
1279
1281
1275
Display
Panel Driver
LCD
Panel
1274
Data
Transfer
Activation
Switch
1277
Keypad
Driver
Touch
Keypad
1276
1280
Data
Transfer
Mechanism
Host
Automatic with Laser Based Object Detection

FIG. 40A3



Automatic with Passive CCD Based Object Detection

FIG. 40A4

601/594

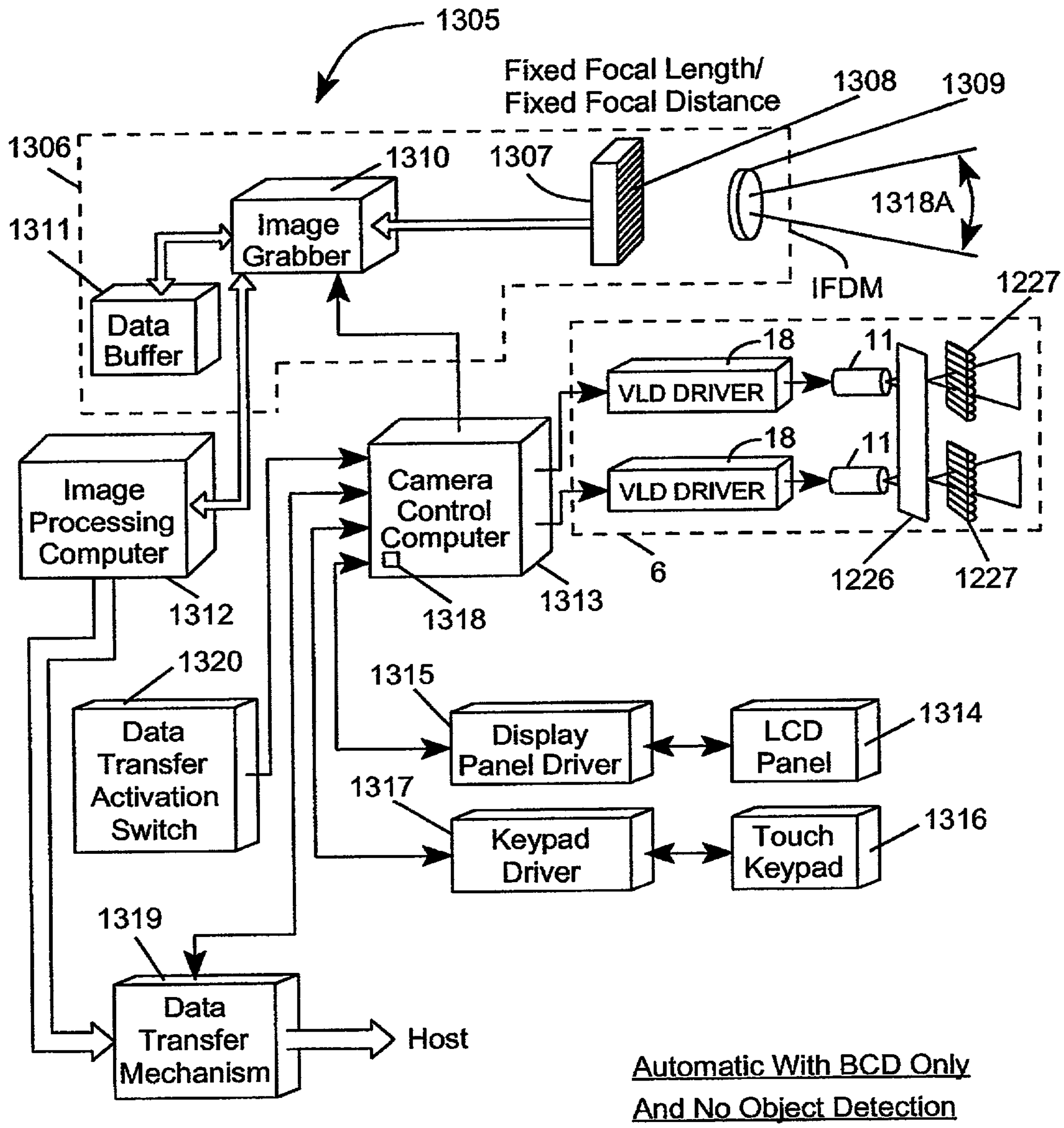


FIG. 40A5

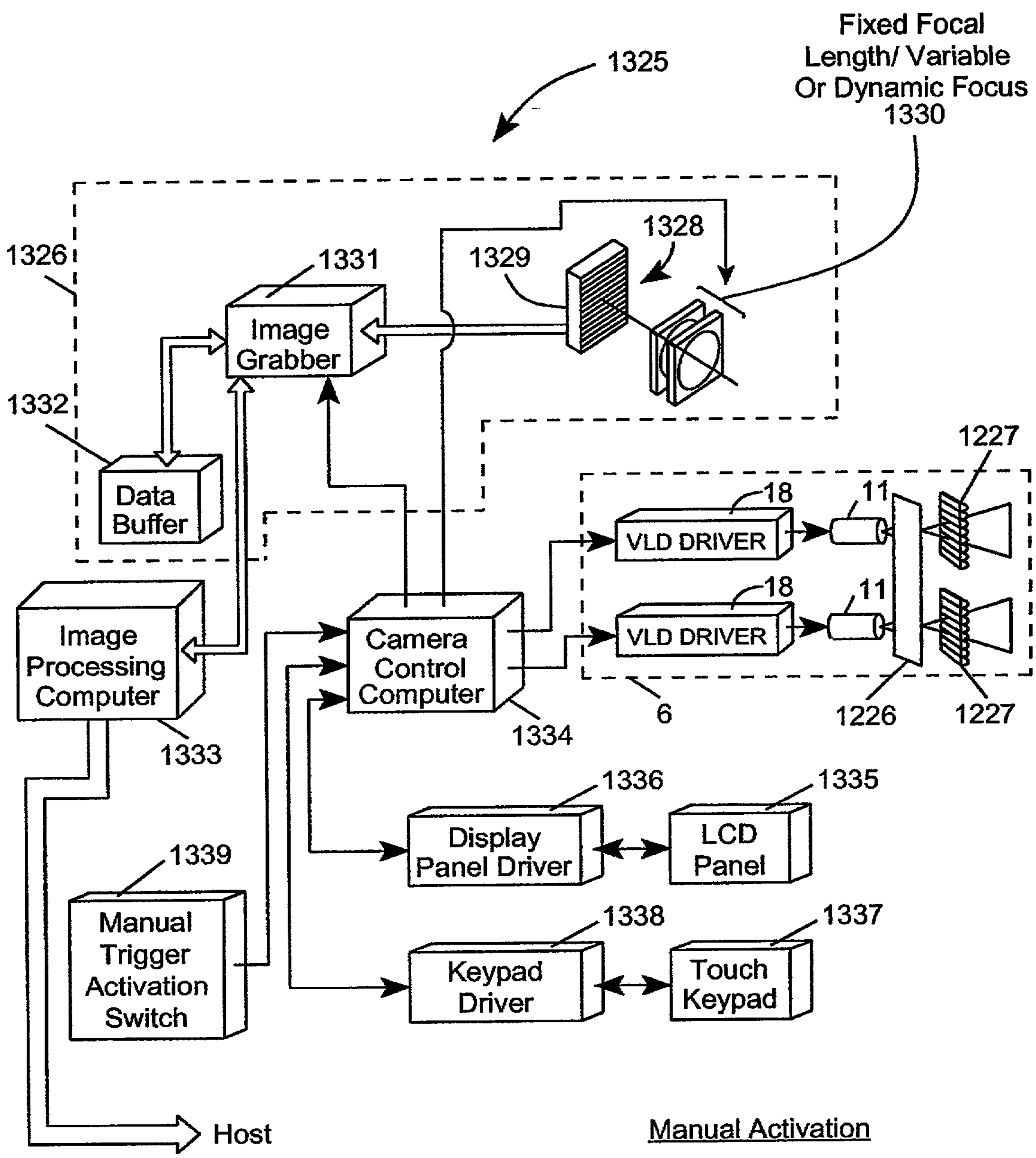
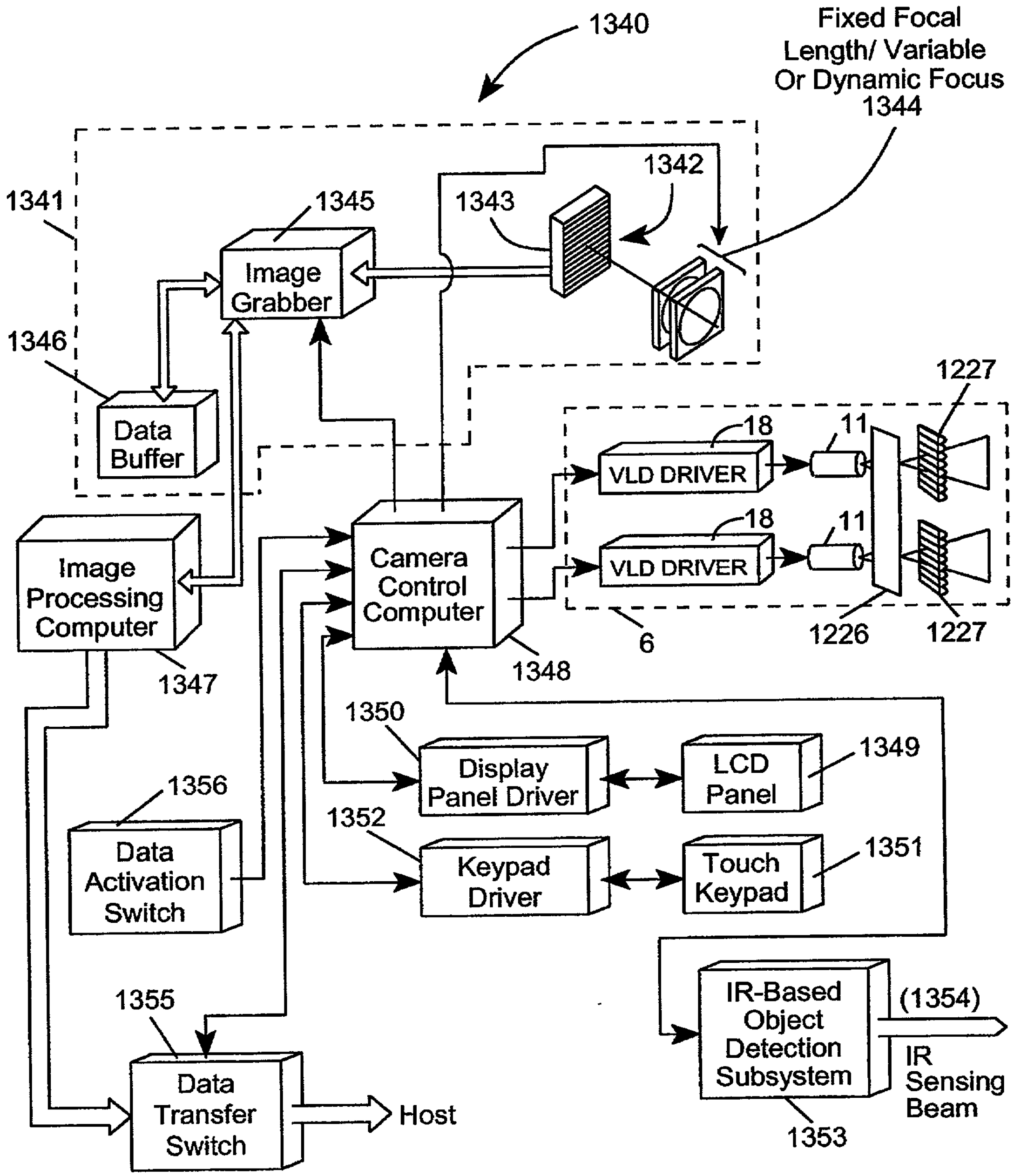
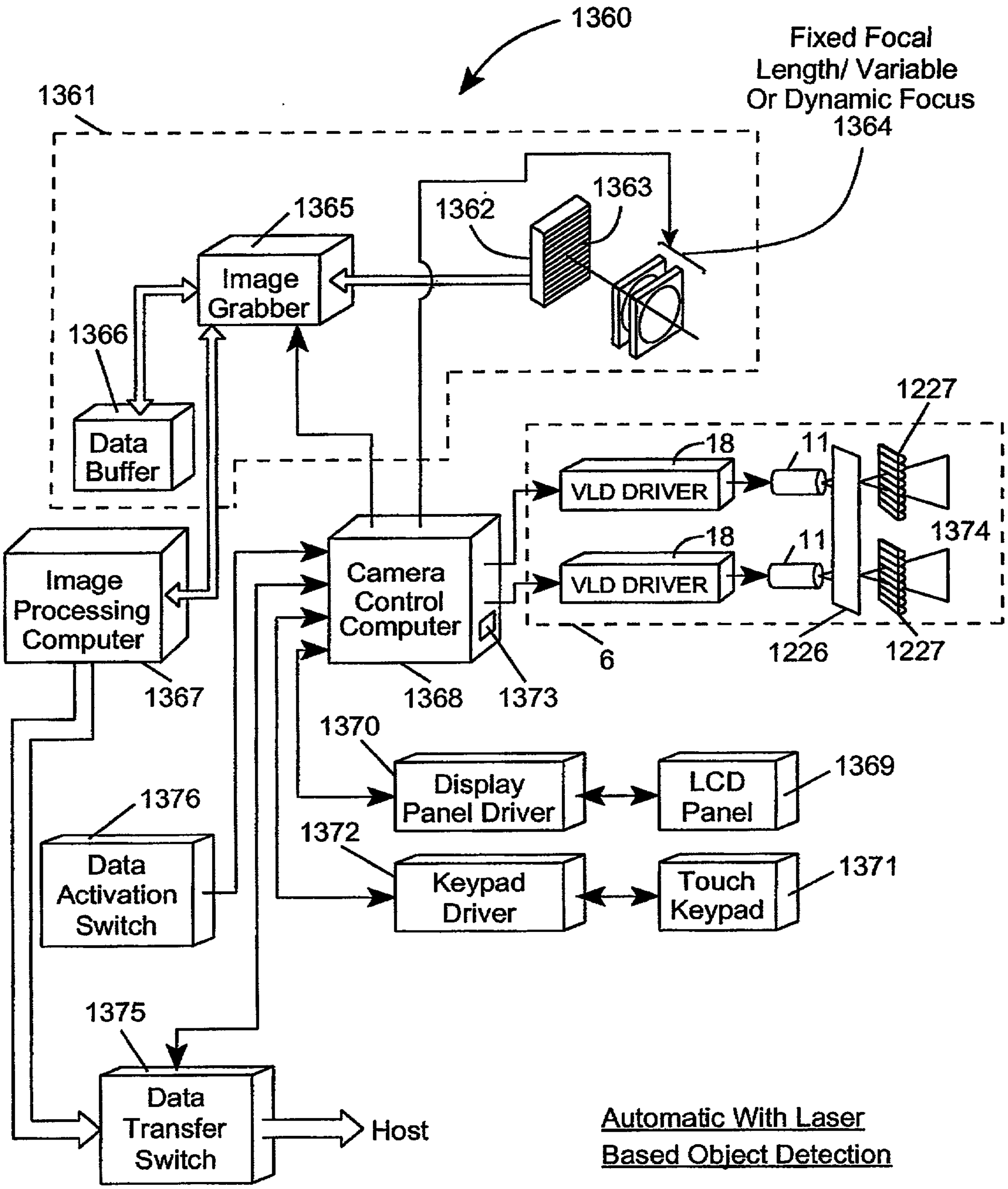

1325
Fixed Focal
Length/ Variable
Or Dynamic Focus
1330
1326
1331
Image
Grabber
1329
1328
1332
Data
Buffer
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
Image
Processing
Computer
Camera
Control
Computer
1333
1334
6
1226
1227
1336
Display
Panel Driver
1335
LCD
Panel
1339
Manual
Trigger
Activation
Switch
1338
Keypad
Driver
1337
Touch
Keypad
Host
Manual Activation

FIG. 40B1



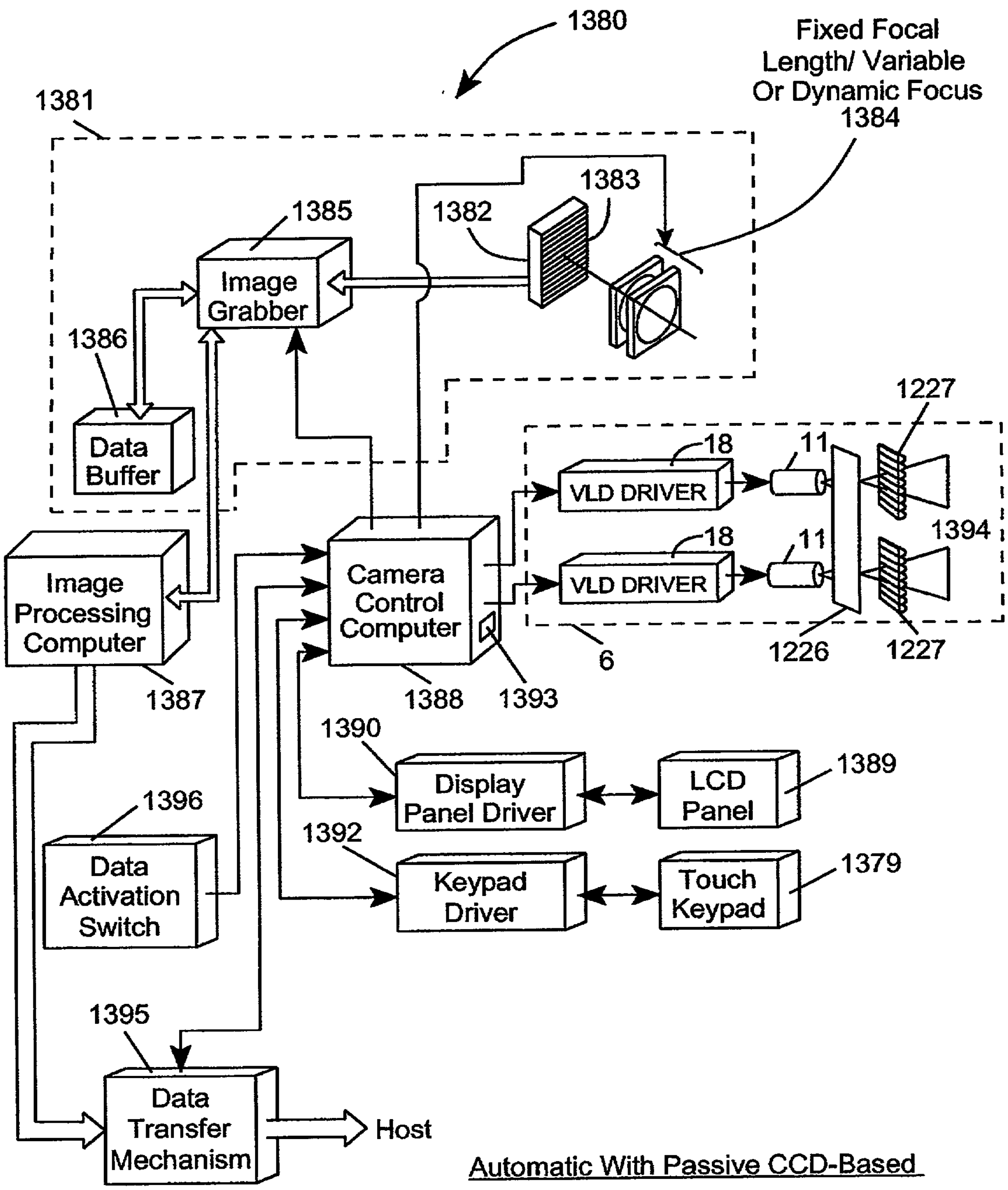
Automatic With IR-Based Object Detection

FIG. 40B2



1360
1361
Fixed Focal Length/ Variable Or Dynamic Focus 1364
1363
1362
1365
Image Grabber
1366
Data Buffer
1227
18
11
VLD DRIVER
1374
18
11
VLD DRIVER
Image Processing Computer
Camera Control Computer
6
1226
1227
1367
1368
1373
1370
Display Panel Driver
LCD Panel
1369
1376
Data Activation Switch
1372
Keypad Driver
Touch Keypad
1371
1375
Data Transfer Switch
Host
Automatic With Laser Based Object Detection

FIG. 40B3



Automatic With Passive CCD-Based Object Detection

FIG. 40B4

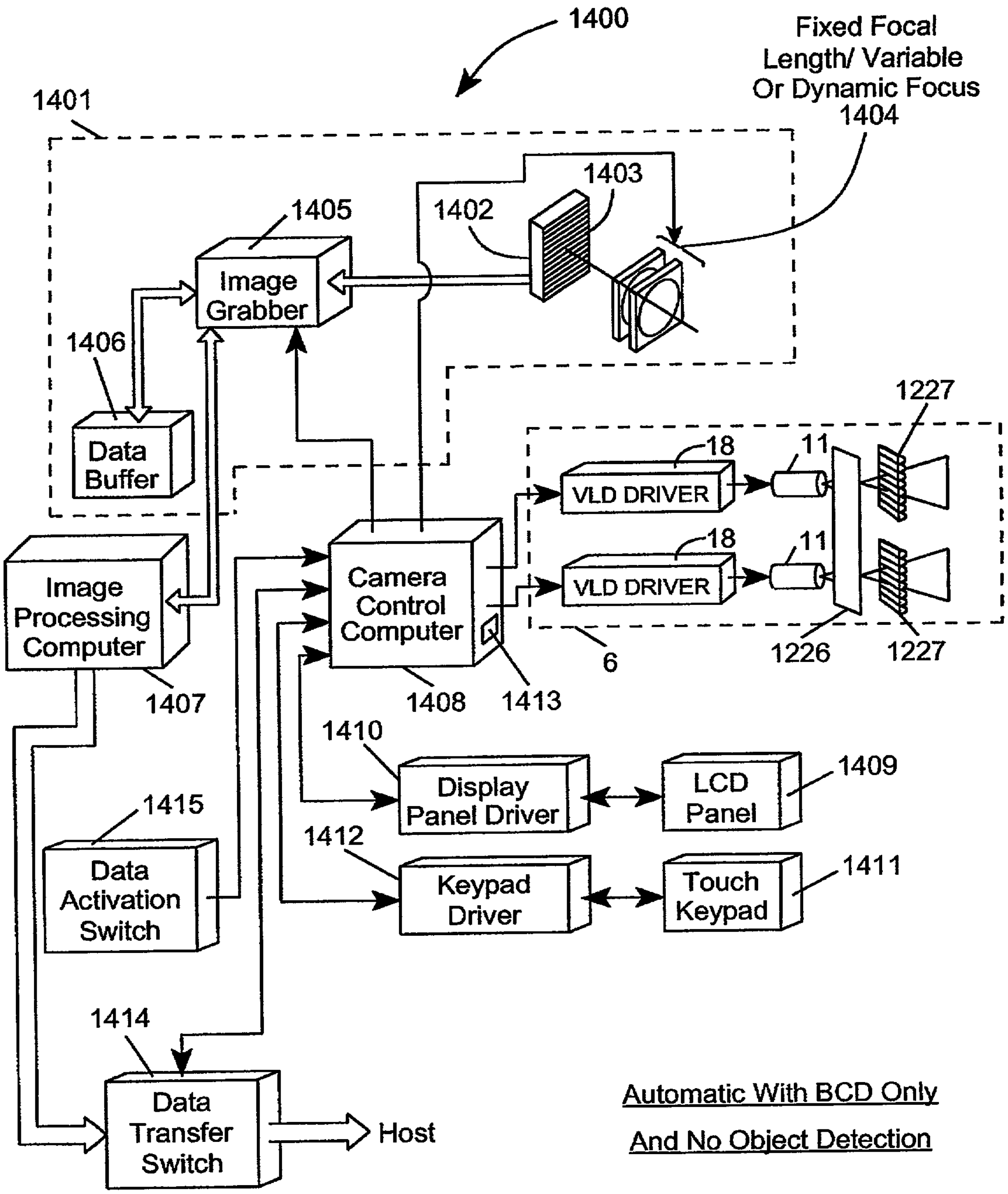
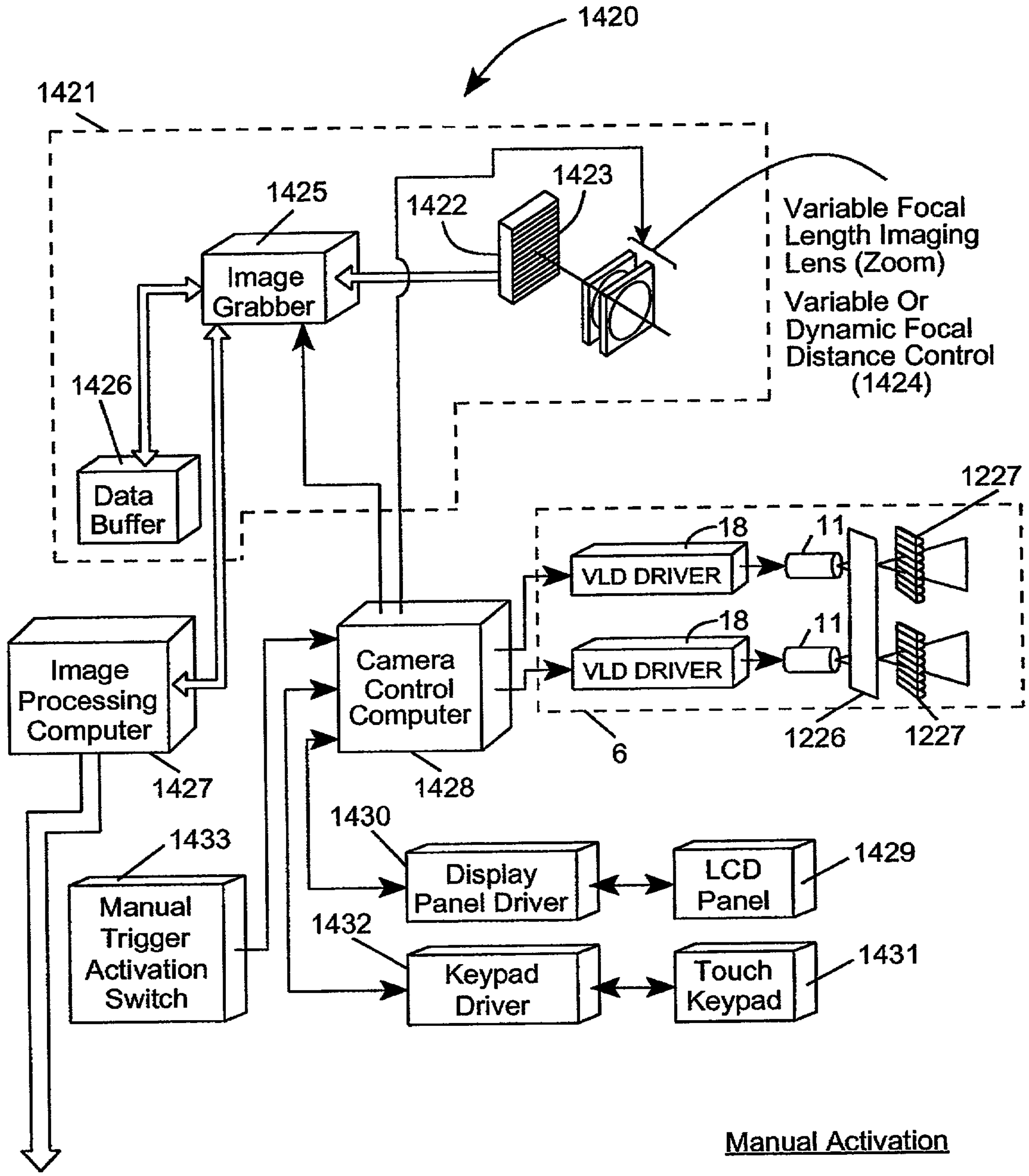

1400
Fixed Focal
Length/ Variable
Or Dynamic Focus
1404
1401
1403
1405
1402
Image
Grabber
1406
Data
Buffer
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
Image
Processing
Computer
Camera
Control
Computer
1407
1408
1413
6
1226
1227
1410
Display
Panel Driver
LCD
Panel
1409
1415
Data
Activation
Switch
1412
Keypad
Driver
Touch
Keypad
1411
1414
Data
Transfer
Switch
Host
Automatic With BCD Only
And No Object Detection

FIG. 40B5



1420
1421
1425
Image Grabber
1422
1423
Variable Focal Length Imaging Lens (Zoom)
Variable Or Dynamic Focal Distance Control (1424)
1426
Data Buffer
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
Image Processing Computer
1427
Camera Control Computer
1428
6
1226
1227
1430
1433
Display Panel Driver
LCD Panel
1429
Manual Trigger Activation Switch
1432
Keypad Driver
Touch Keypad
1431
Manual Activation

FIG. 40C1

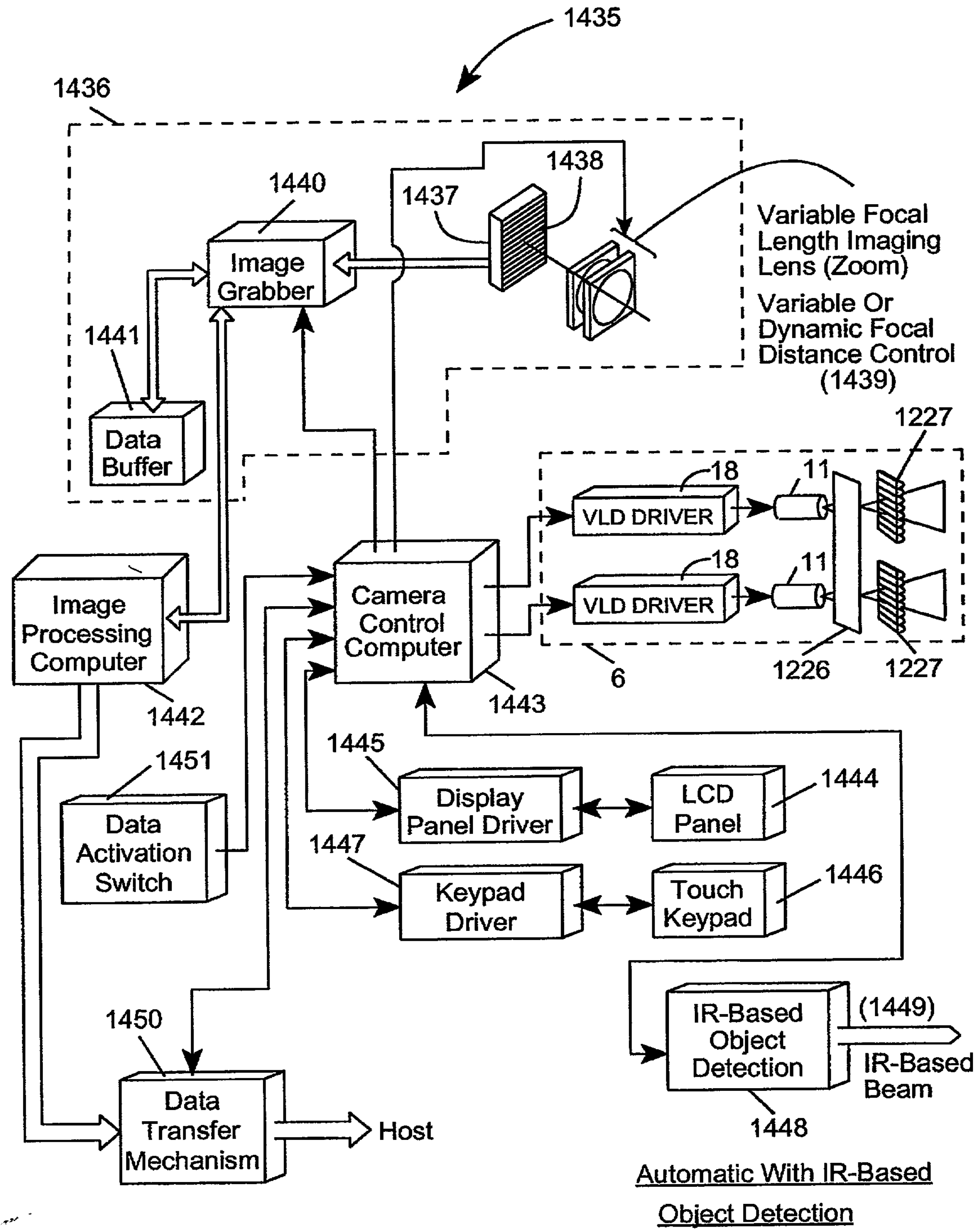

1435
1436
1440
Image Grabber
1437
1438
Variable Focal Length Imaging Lens (Zoom)
Variable Or Dynamic Focal Distance Control (1439)
1441
Data Buffer
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
Image Processing Computer
Camera Control Computer
6
1226
1227
1442
1443
1445
1451
Display Panel Driver
LCD Panel
1444
Data Activation Switch
1447
Keypad Driver
Touch Keypad
1446
1450
IR-Based Object Detection
(1449)
IR-Based Beam
Data Transfer Mechanism
Host
1448
Automatic With IR-Based Object Detection

FIG. 40C2

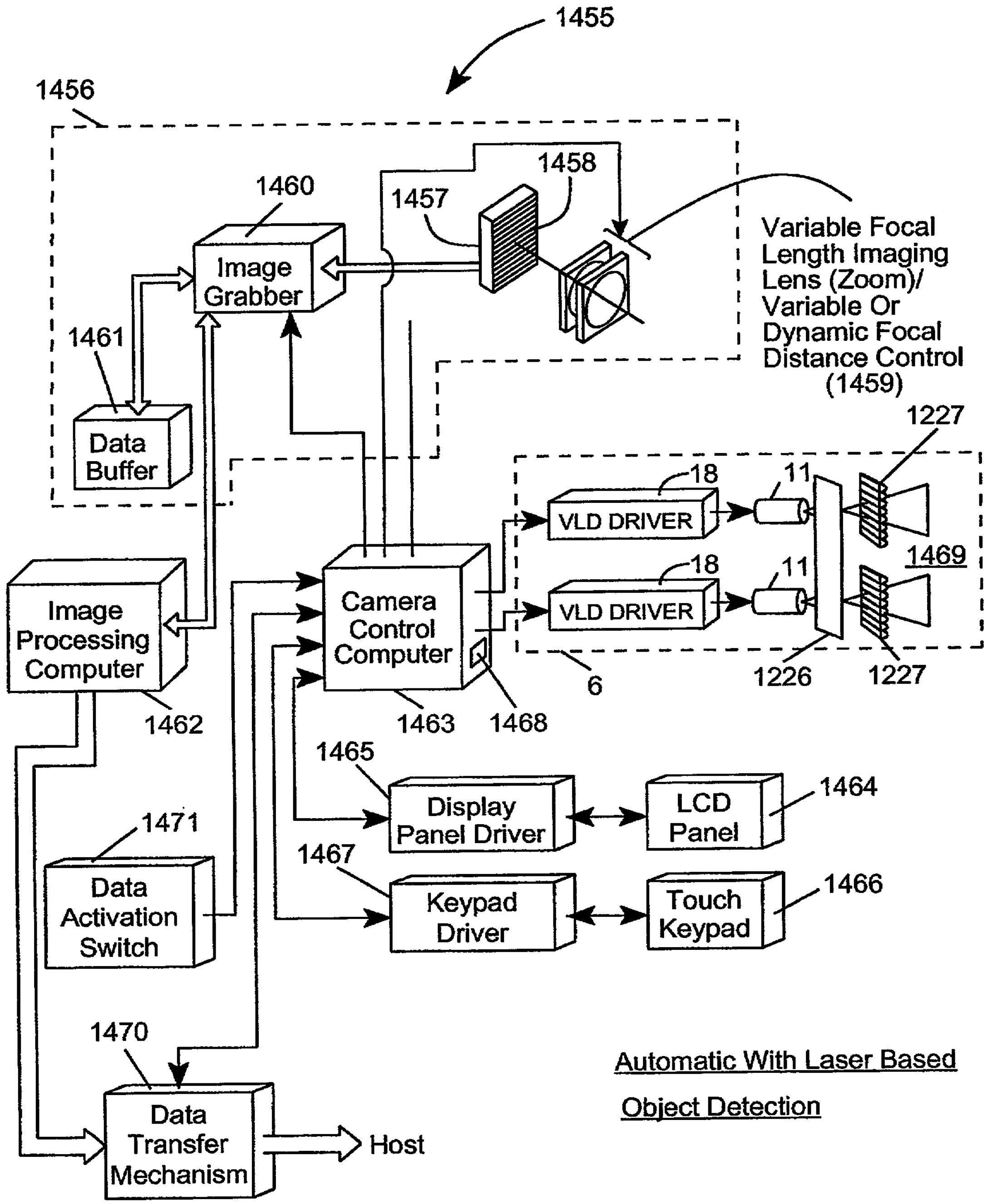

1455
1456
1460
Image Grabber
1457
1458
Variable Focal Length Imaging Lens (Zoom)/ Variable Or Dynamic Focal Distance Control (1459)
1461
Data Buffer
1227
18
11
VLD DRIVER
18
11
VLD DRIVER
1469
1226
1227
6
Image Processing Computer
1462
Camera Control Computer
1463
1468
1465
Display Panel Driver
LCD Panel
1464
1471
Data Activation Switch
1467
Keypad Driver
Touch Keypad
1466
1470
Data Transfer Mechanism
Host
Automatic With Laser Based Object Detection

FIG. 40C3

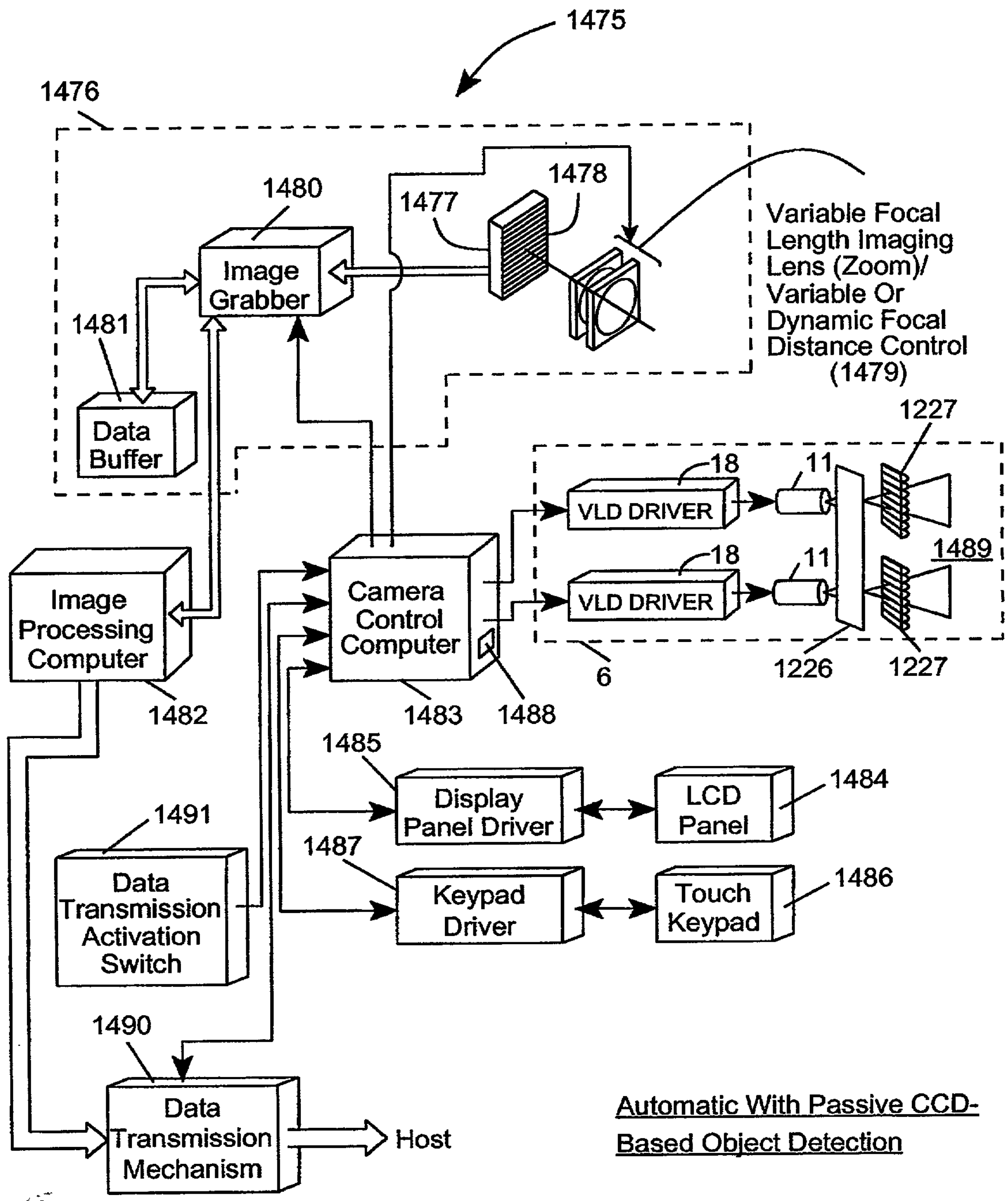
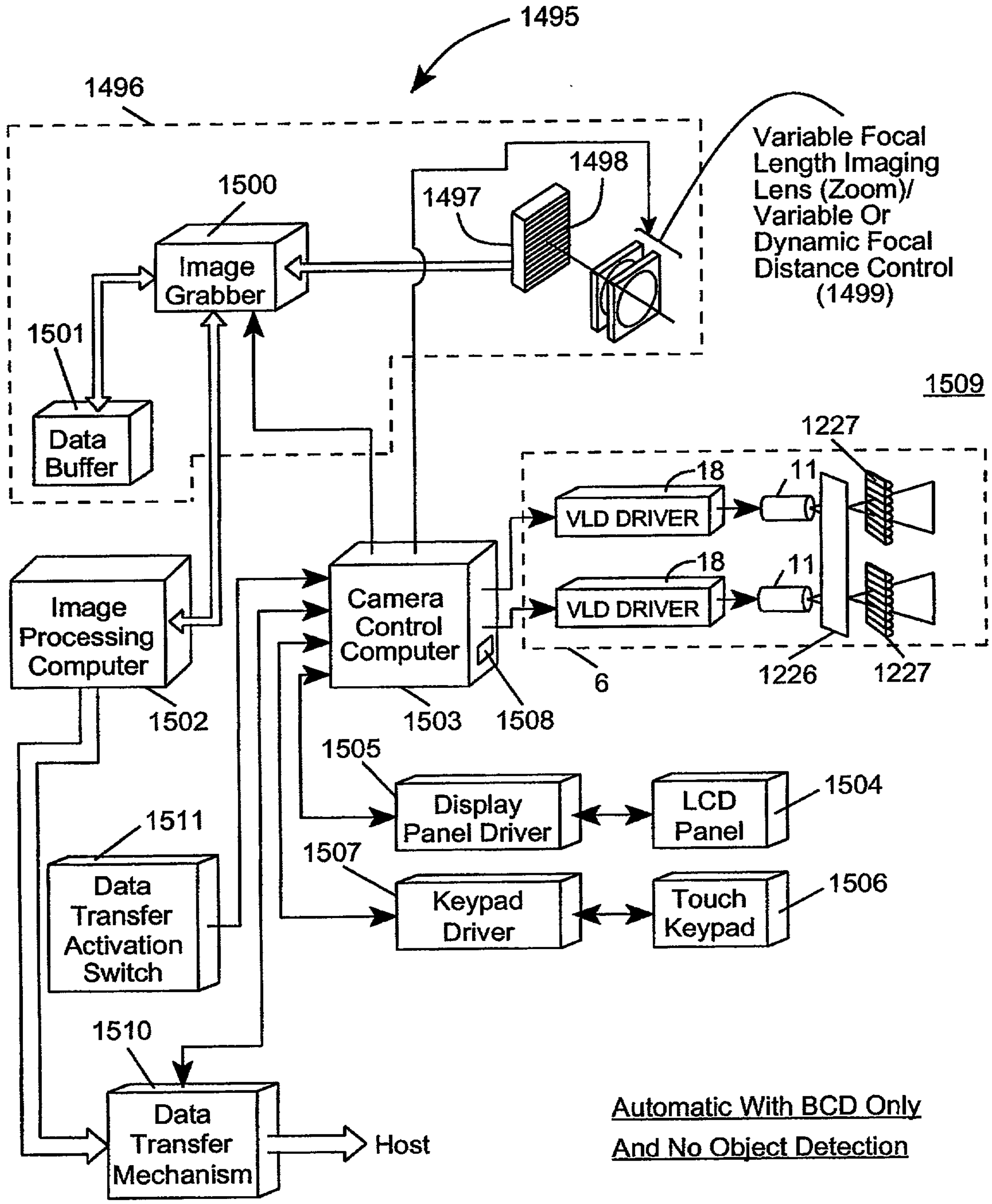

1475
1476
1480
1477
1478
Image Grabber
Variable Focal Length Imaging Lens (Zoom)/ Variable Or Dynamic Focal Distance Control (1479)
1481
Data Buffer
1227
18
11
VLD DRIVER
1489
Image Processing Computer
Camera Control Computer
1482
1483
1488
6
1226
1485
Display Panel Driver
LCD Panel
1484
1491
1487
Keypad Driver
Touch Keypad
1486
Data Transmission Activation Switch
1490
Data Transmission Mechanism
Host
Automatic With Passive CCD-Based Object Detection

FIG. 40C4



1495
1496
1500
Image Grabber
1497
1498
Variable Focal Length Imaging Lens (Zoom)/ Variable Or Dynamic Focal Distance Control (1499)
1501
Data Buffer
1509
1227
18
11
VLD DRIVER
VLD DRIVER
6
1226
1227
Image Processing Computer
1502
Camera Control Computer
1503
1508
1505
Display Panel Driver
LCD Panel
1504
1511
1507
Keypad Driver
Touch Keypad
1506
Data Transfer Activation Switch
1510
Data Transfer Mechanism
Host
Automatic With BCD Only
And No Object Detection

FIG. 40C5

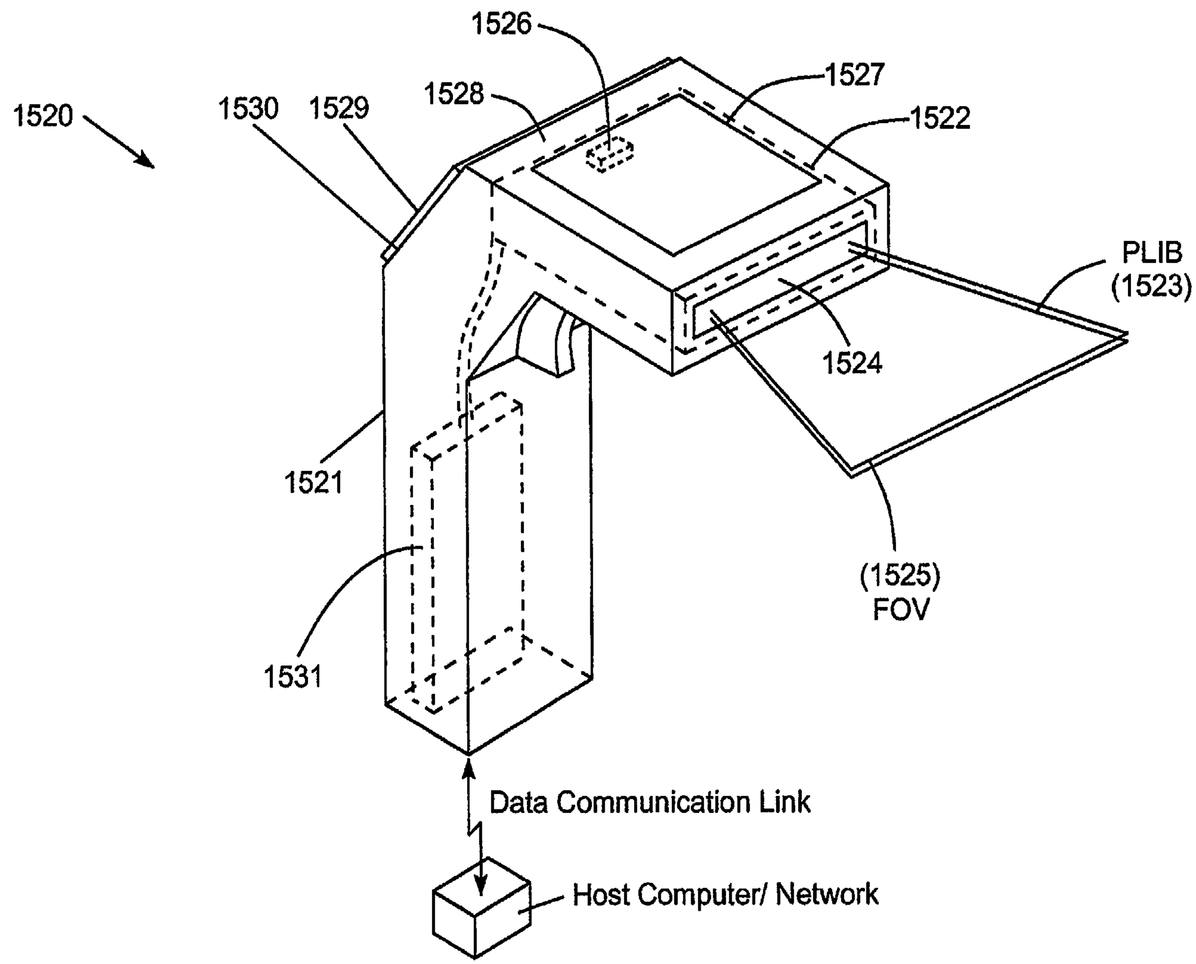

1520
1530
1529
1528
1526
1527
1522
PLIB
(1523)
1524
1521
1531
(1525)
FOV
Data Communication Link
Host Computer/ Network

FIG. 41A

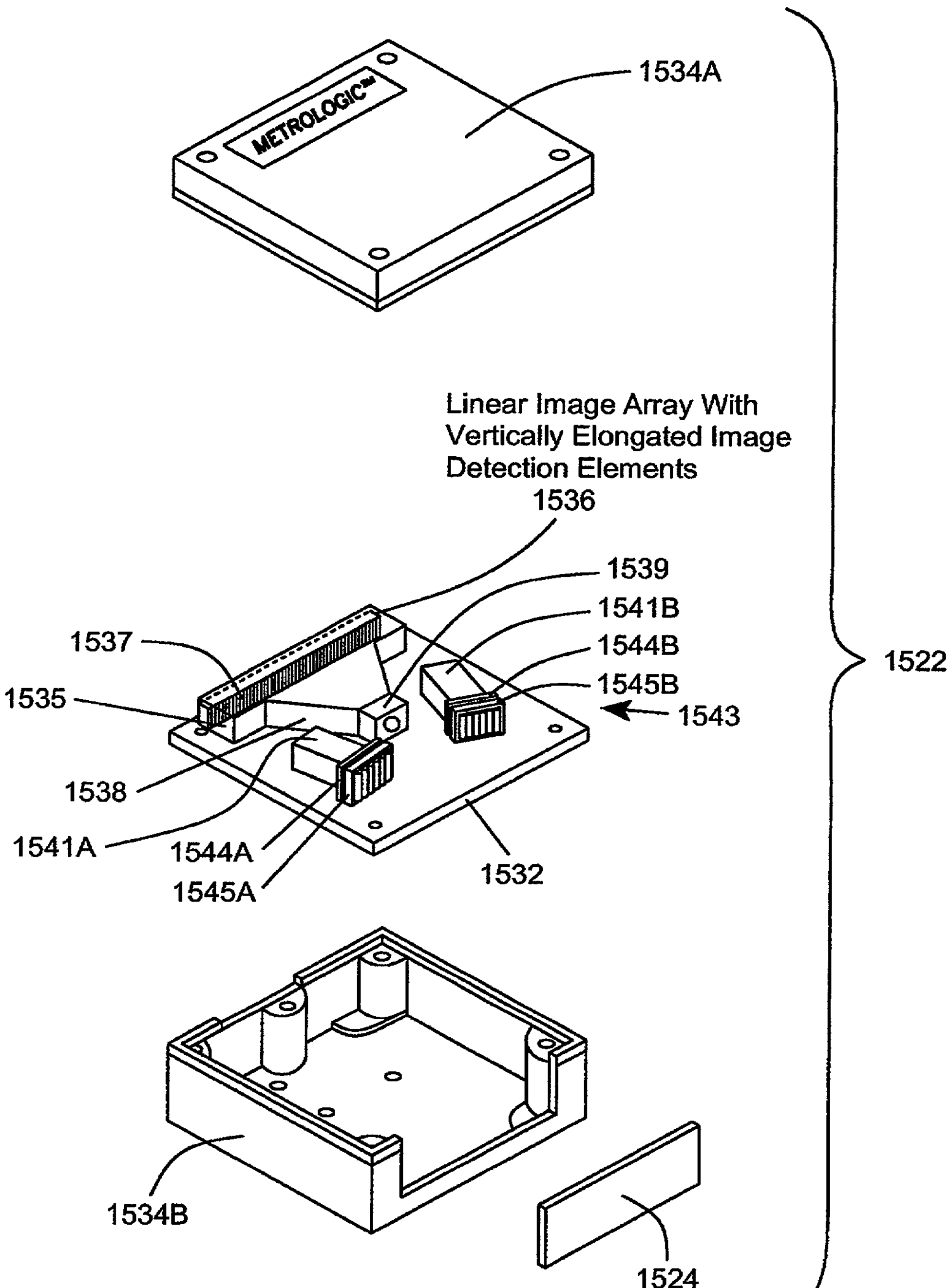

1534A
METROLOGIC
Linear Image Array With
Vertically Elongated Image
Detection Elements
1536
1539
1541B
1544B
1545B
1543
1537
1535
1538
1541A
1544A
1545A
1532
1522
1534B
1524

FIG. 41B

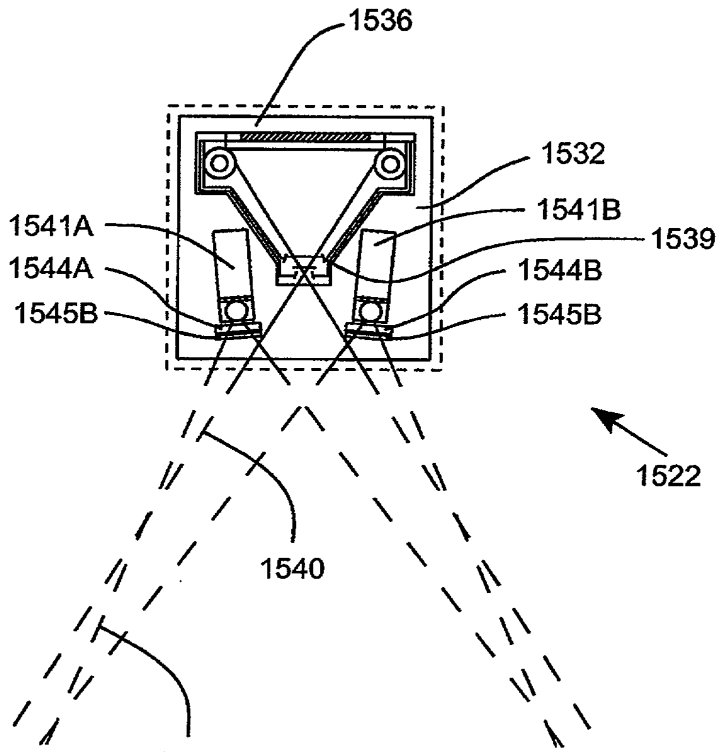


FIG. 41C

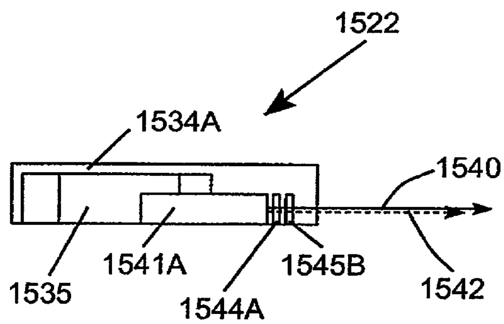


FIG. 41D

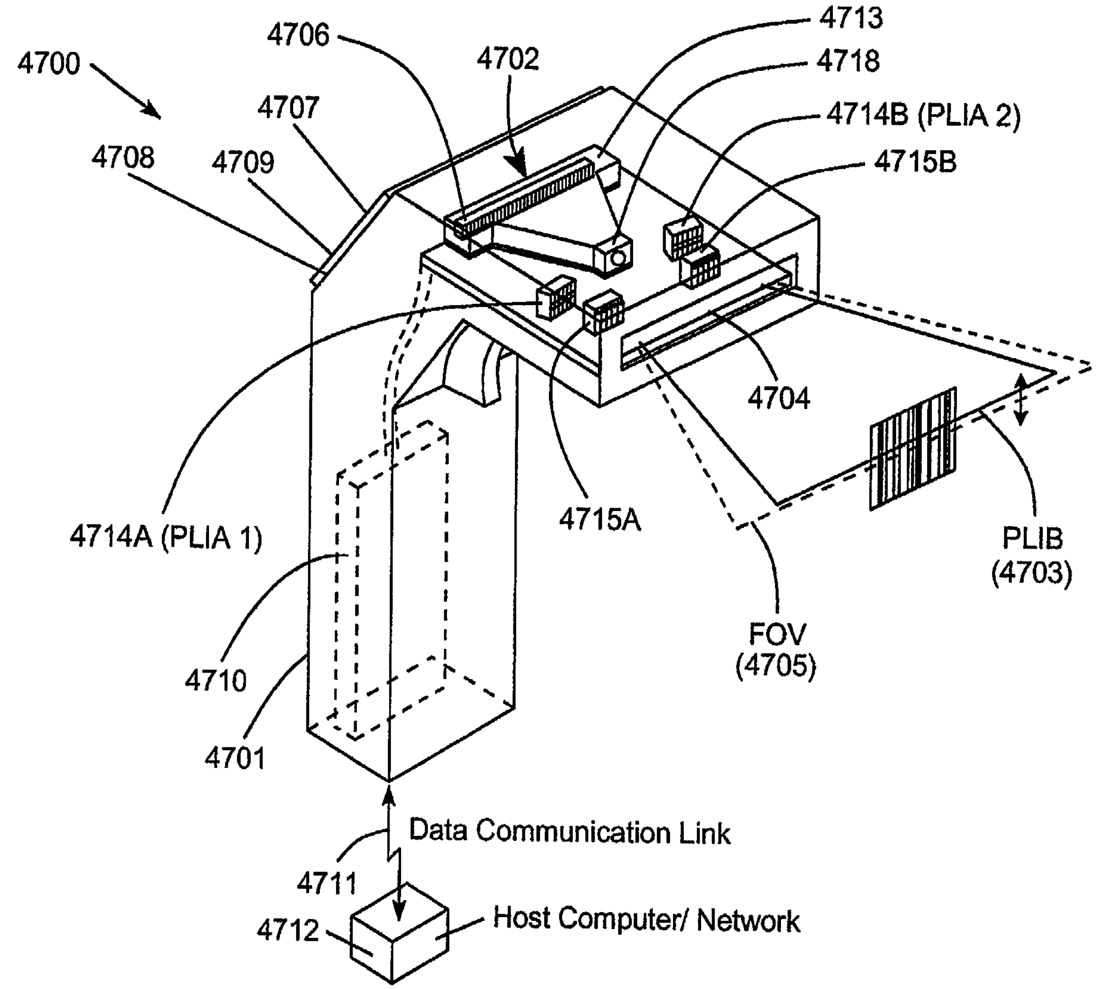

4700
4706
4702
4713
4718
4714B (PLIA 2)
4715B
4707
4708
4709
4714A (PLIA 1)
4715A
4704
PLIB
(4703)
FOV
(4705)
4710
4701
Data Communication Link
4711
4712
Host Computer/ Network

FIG. 42

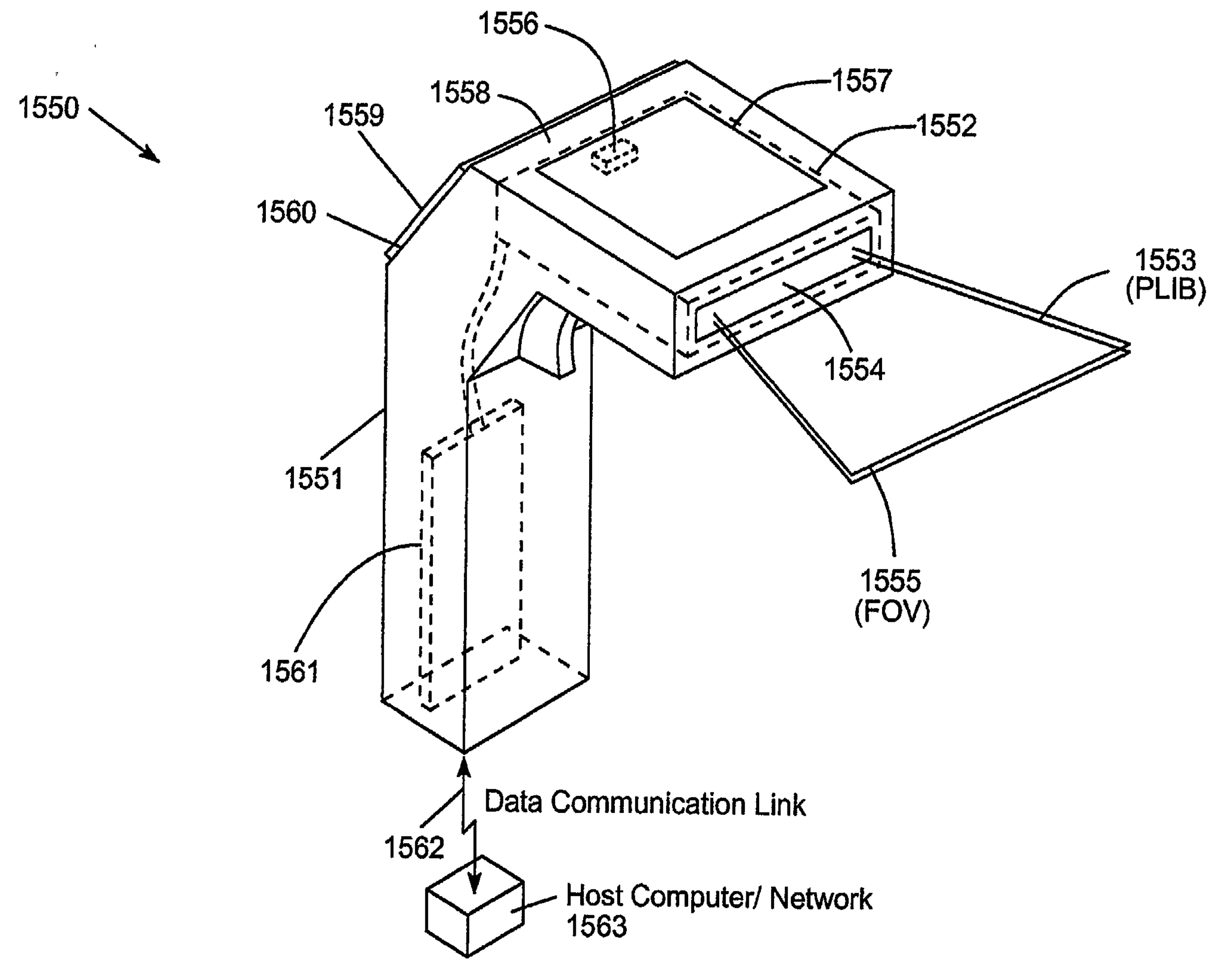

1550
1556
1558
1559
1560
1557
1552
1553
(PLIB)
1554
1551
1561
1555
(FOV)
Data Communication Link
1562
Host Computer/ Network
1563

FIG. 42A

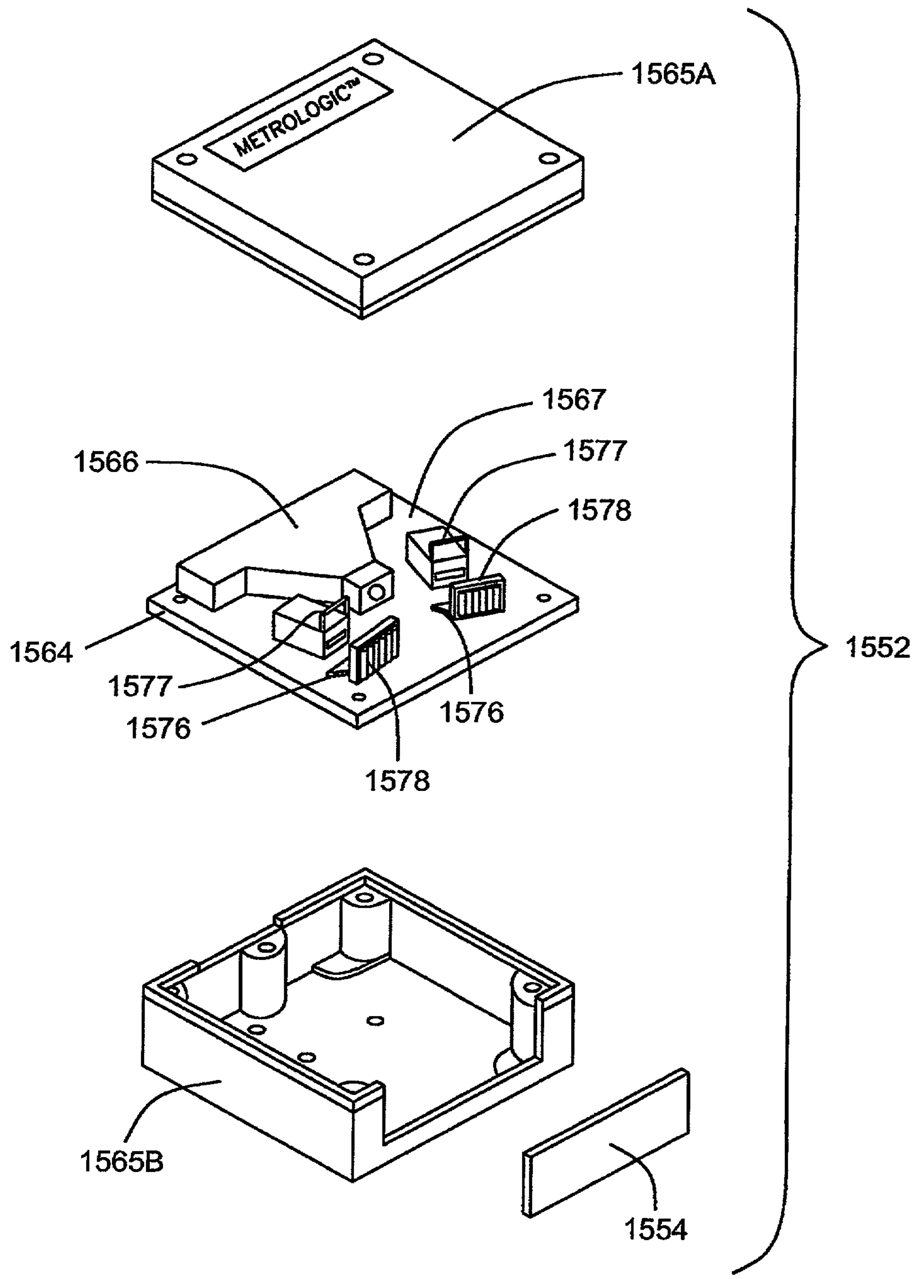

METROLOGIC™
1565A
1567
1577
1566
1578
1564
1552
1577
1576
1576
1578
1565B
1554

FIG. 42B

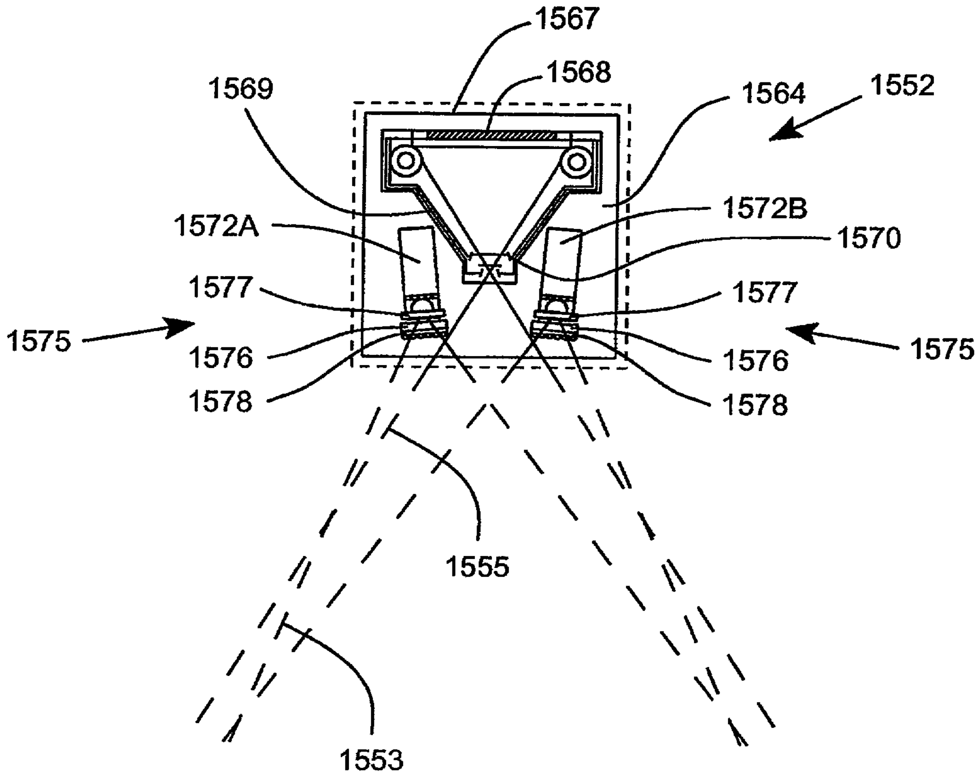


FIG. 42C

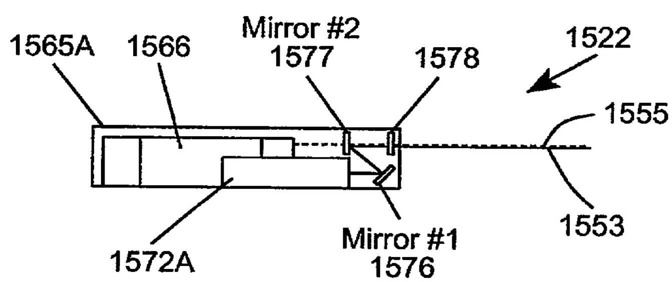


FIG. 42D

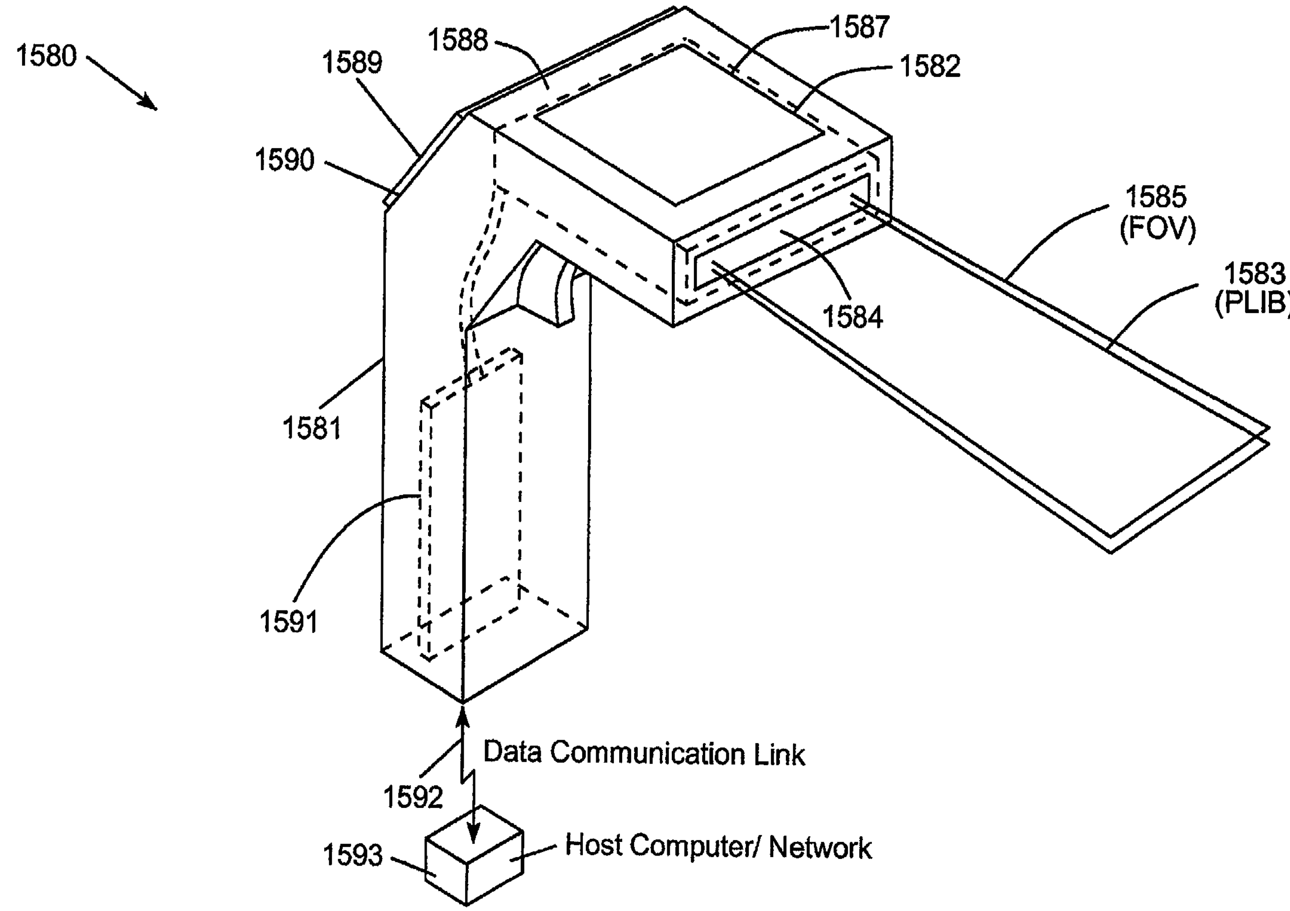

1580
1589
1588
1587
1582
1590
1585
(FOV)
1583
(PLIB)
1584
1581
1591
Data Communication Link
1592
1593
Host Computer/ Network

FIG. 43A

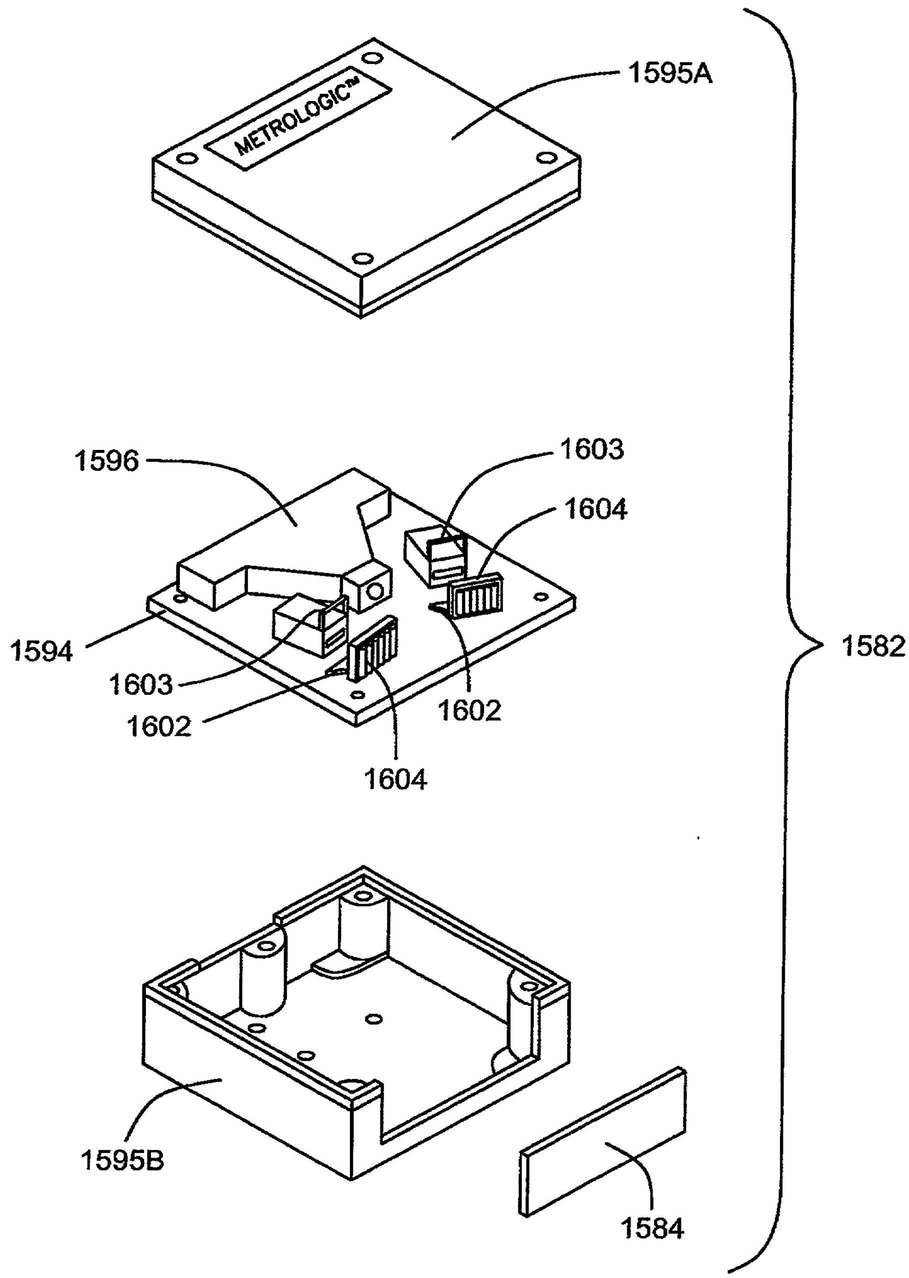

1595A
METROLOGIC™
1596
1603
1604
1594
1603
1602
1602
1604
1582
1595B
1584

FIG. 43B

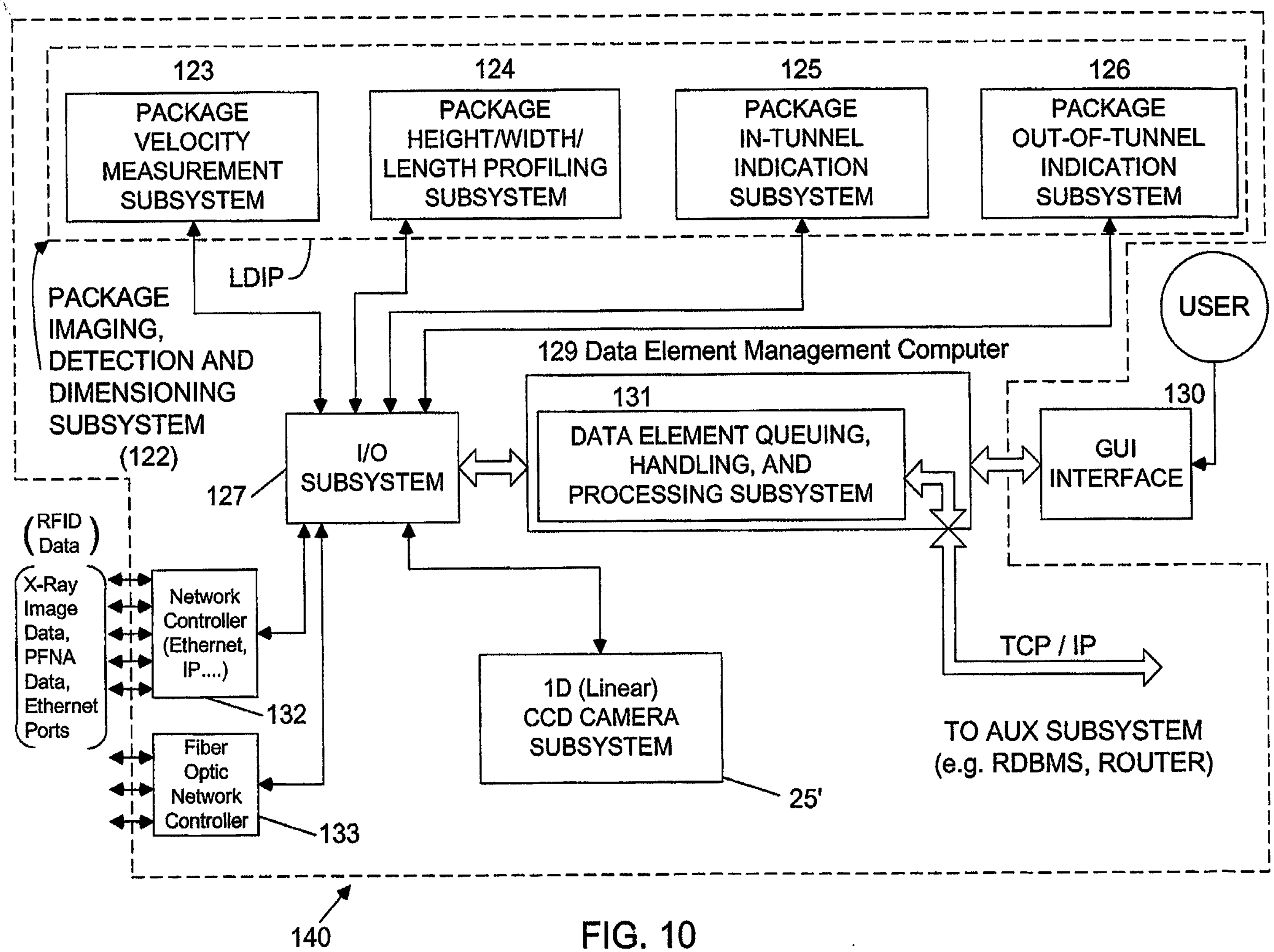
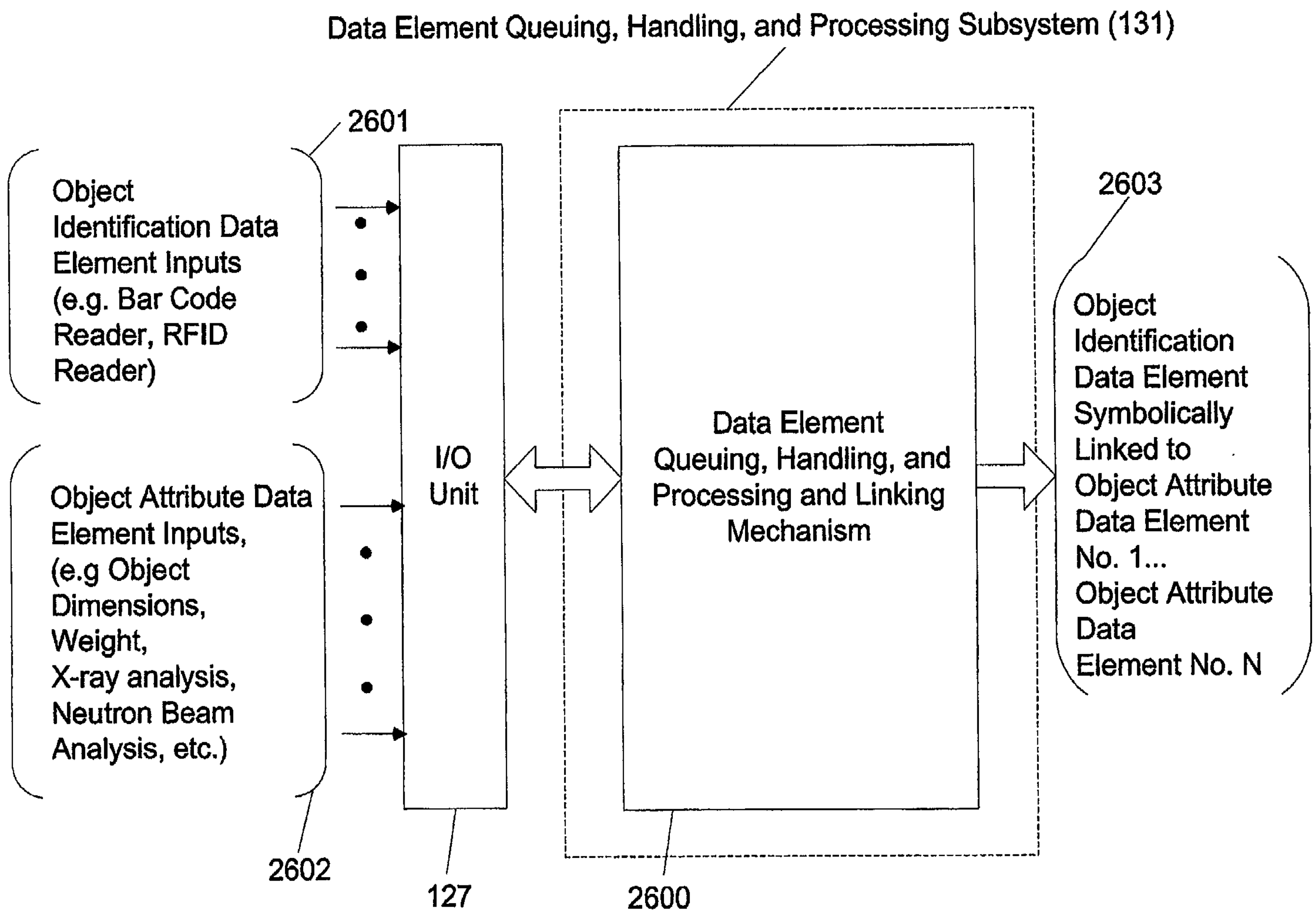

123
PACKAGE VELOCITY MEASUREMENT SUBSYSTEM
124
PACKAGE HEIGHT/WIDTH/ LENGTH PROFILING SUBSYSTEM
125
PACKAGE IN-TUNNEL INDICATION SUBSYSTEM
126
PACKAGE OUT-OF-TUNNEL INDICATION SUBSYSTEM
LDIP
PACKAGE IMAGING, DETECTION AND DIMENSIONING SUBSYSTEM (122)
USER
129 Data Element Management Computer
131
DATA ELEMENT QUEUING, HANDLING, AND PROCESSING SUBSYSTEM
130
GUI INTERFACE
127
I/O SUBSYSTEM
(RFID Data)
X-Ray Image Data, PFNA Data, Ethernet Ports
Network Controller (Ethernet, IP....)
132
Fiber Optic Network Controller
133
1D (Linear) CCD CAMERA SUBSYSTEM
25'
TCP / IP
TO AUX SUBSYSTEM (e.g. RDBMS, ROUTER)
140

FIG. 10



Data Element Queuing, Handling, and Processing Subsystem (131)
2601
Object Identification Data Element Inputs (e.g. Bar Code Reader, RFID Reader)
Object Attribute Data Element Inputs, (e.g Object Dimensions, Weight, X-ray analysis, Neutron Beam Analysis, etc.)
2602
I/O Unit
127
Data Element Queuing, Handling, and Processing and Linking Mechanism
2600
2603
Object Identification Data Element Symbolically Linked to Object Attribute Data Element No. 1... Object Attribute Data Element No. N

FIG. 10A

Primary Network and/ or System Functions:

A. Specification of Object Detection and Tracking Capability of System

B. Specification of Object Identification Capability of System

C. Specification of Object Attribute Acquisition Capability of System

Specification of Object Detection, Tracking, and Identification and Attribute-Acquisition Capabilities of a Configured System or Network.

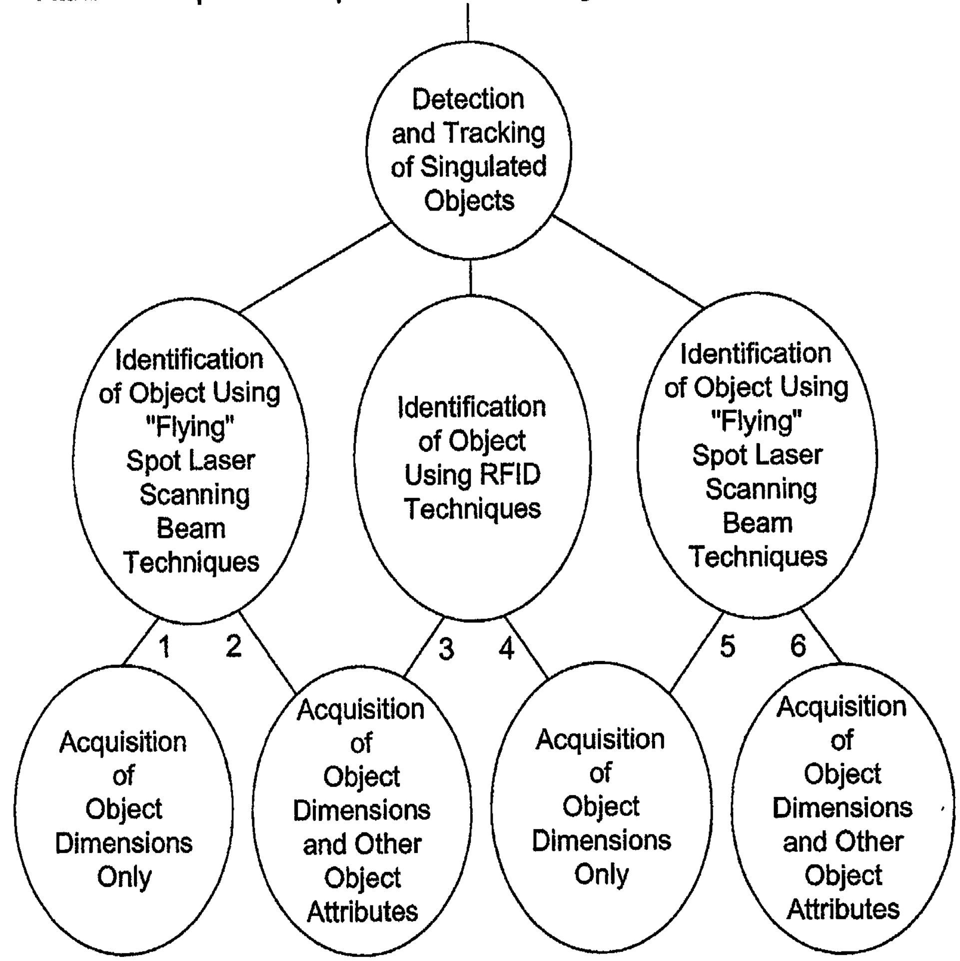


FIG. 10B-1

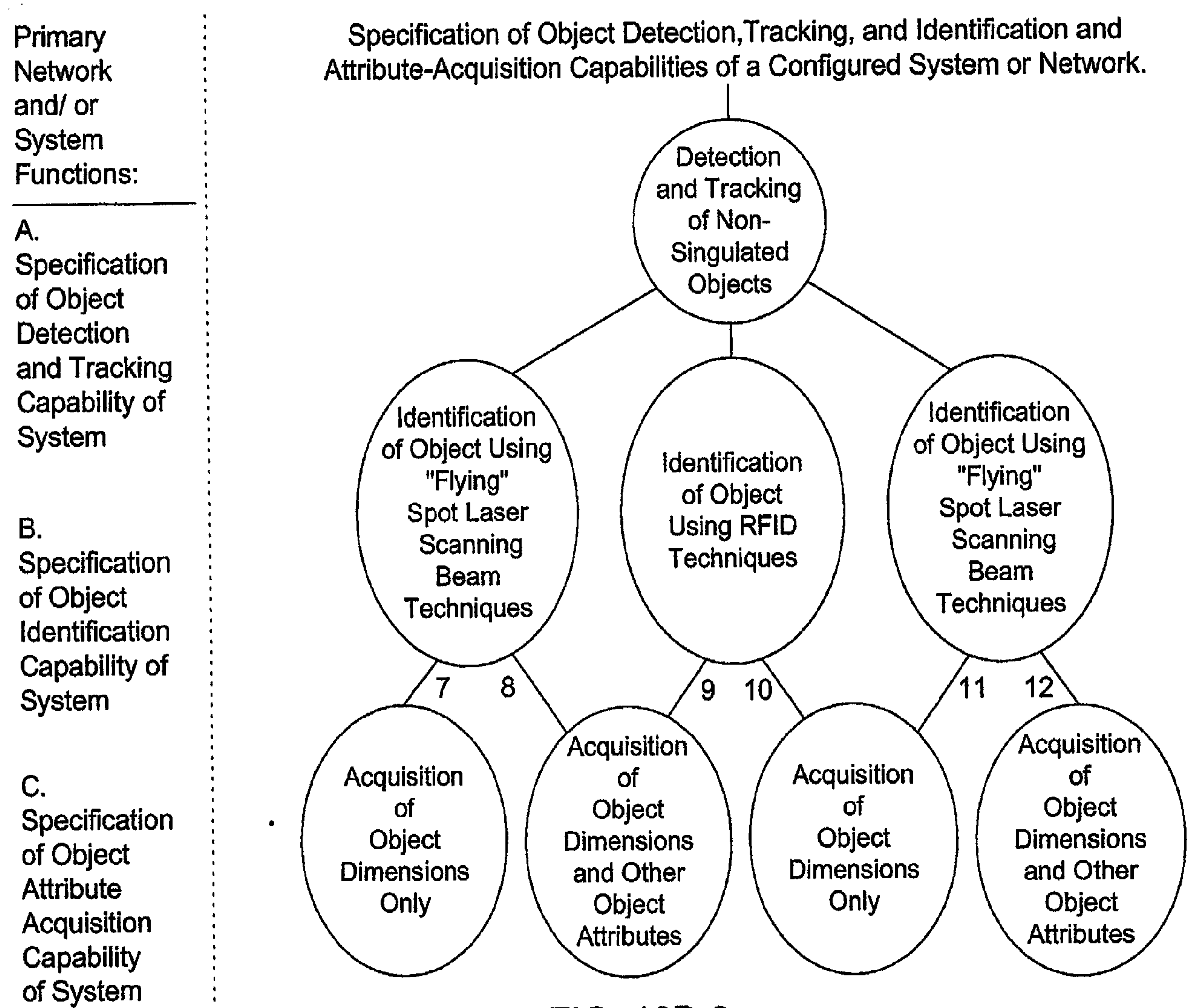

Primary Network and/ or System Functions:
A. Specification of Object Detection and Tracking Capability of System
B. Specification of Object Identification Capability of System
C. Specification of Object Attribute Acquisition Capability of System
Specification of Object Detection,Tracking, and Identification and Attribute-Acquisition Capabilities of a Configured System or Network.
Detection and Tracking of Non-Singulated Objects
Identification of Object Using "Flying" Spot Laser Scanning Beam Techniques
Identification of Object Using RFID Techniques
Identification of Object Using "Flying" Spot Laser Scanning Beam Techniques
7
8
9
10
11
12
Acquisition of Object Dimensions Only
Acquisition of Object Dimensions and Other Object Attributes
Acquisition of Object Dimensions Only
Acquisition of Object Dimensions and Other Object Attributes

FIG. 10B-2

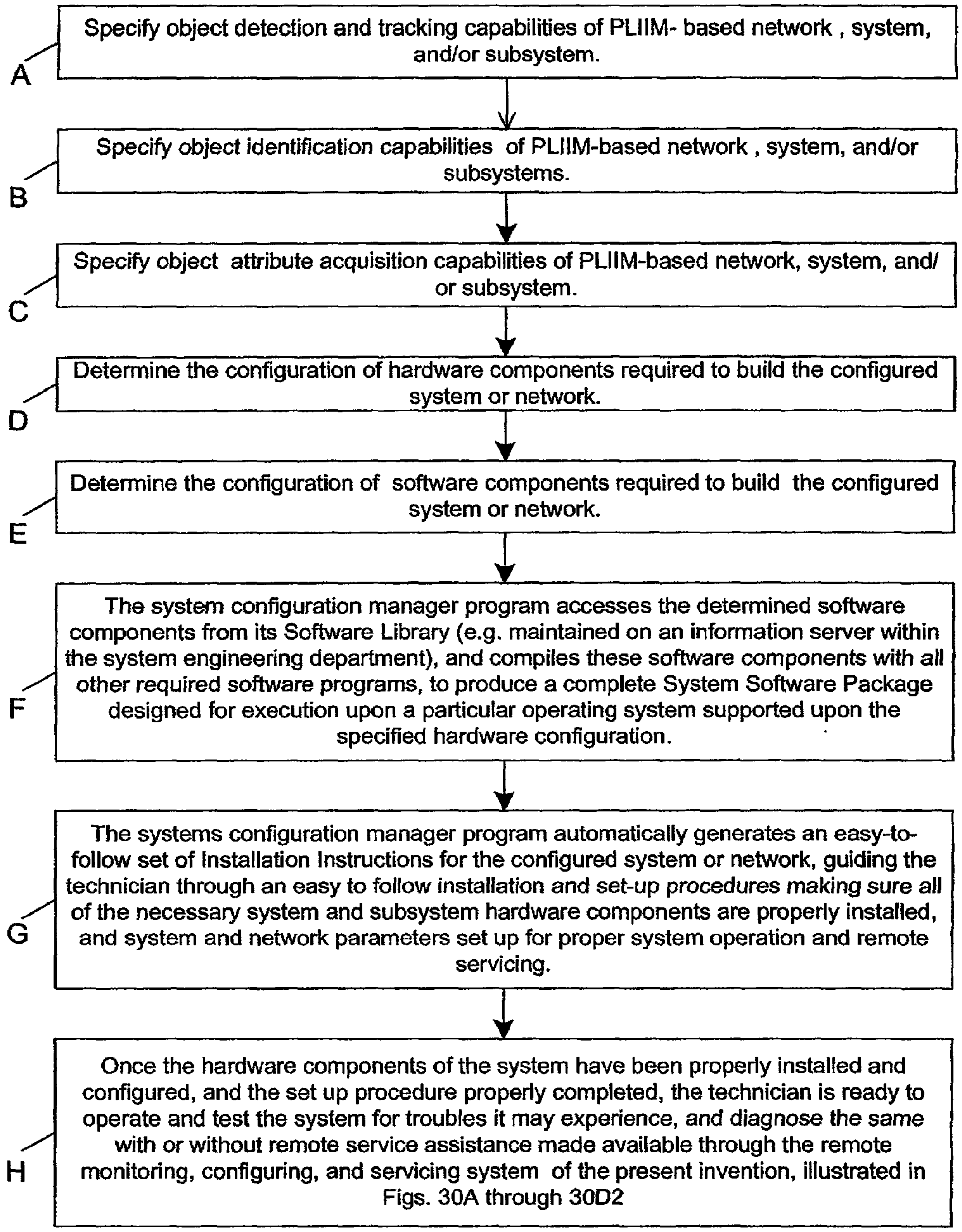
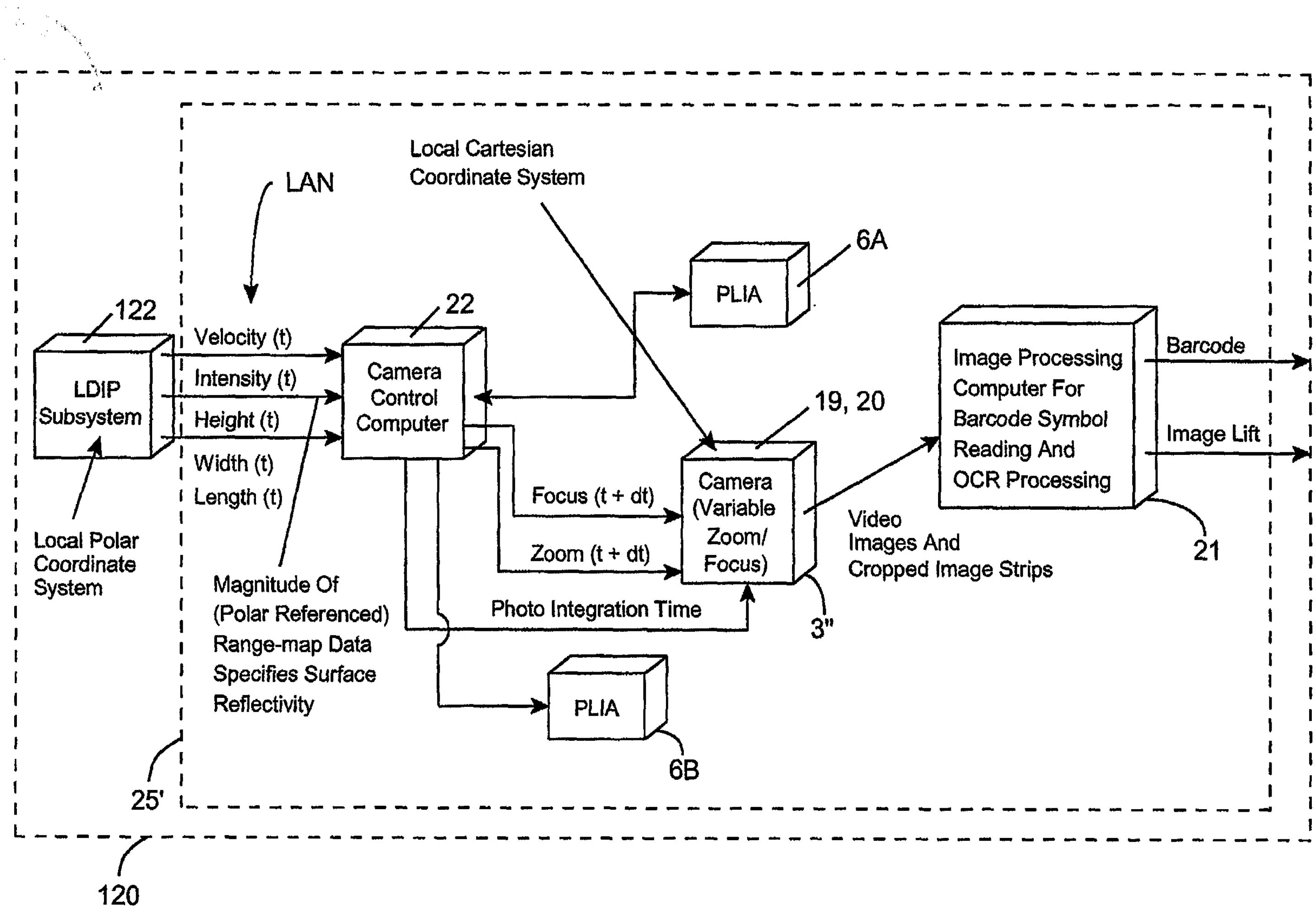

Specify object detection and tracking capabilities of PLIIM- based network , system, and/or subsystem.
A
Specify object identification capabilities of PLIIM-based network , system, and/or subsystems.
B
Specify object attribute acquisition capabilities of PLIIM-based network, system, and/ or subsystem.
C
Determine the configuration of hardware components required to build the configured system or network.
D
Determine the configuration of software components required to build the configured system or network.
E
The system configuration manager program accesses the determined software components from its Software Library (e.g. maintained on an information server within the system engineering department), and compiles these software components with all other required software programs, to produce a complete System Software Package designed for execution upon a particular operating system supported upon the specified hardware configuration.
F
The systems configuration manager program automatically generates an easy-to-follow set of Installation Instructions for the configured system or network, guiding the technician through an easy to follow installation and set-up procedures making sure all of the necessary system and subsystem hardware components are properly installed, and system and network parameters set up for proper system operation and remote servicing.
G
Once the hardware components of the system have been properly installed and configured, and the set up procedure properly completed, the technician is ready to operate and test the system for troubles it may experience, and diagnose the same with or without remote service assistance made available through the remote monitoring, configuring, and servicing system of the present invention, illustrated in Figs. 30A through 30D2
H

FIG. 10C



Local Cartesian Coordinate System
LAN
6A
PLIA
122
LDIP Subsystem
Local Polar Coordinate System
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
22
Camera Control Computer
Magnitude Of (Polar Referenced) Range-map Data Specifies Surface Reflectivity
Focus (t + dt)
Zoom (t + dt)
Photo Integration Time
19, 20
Camera (Variable Zoom/ Focus)
3"
PLIA
6B
Video Images And Cropped Image Strips
Image Processing Computer For Barcode Symbol Reading And OCR Processing
21
Barcode
Image Lift
25'
120

FIG. 11

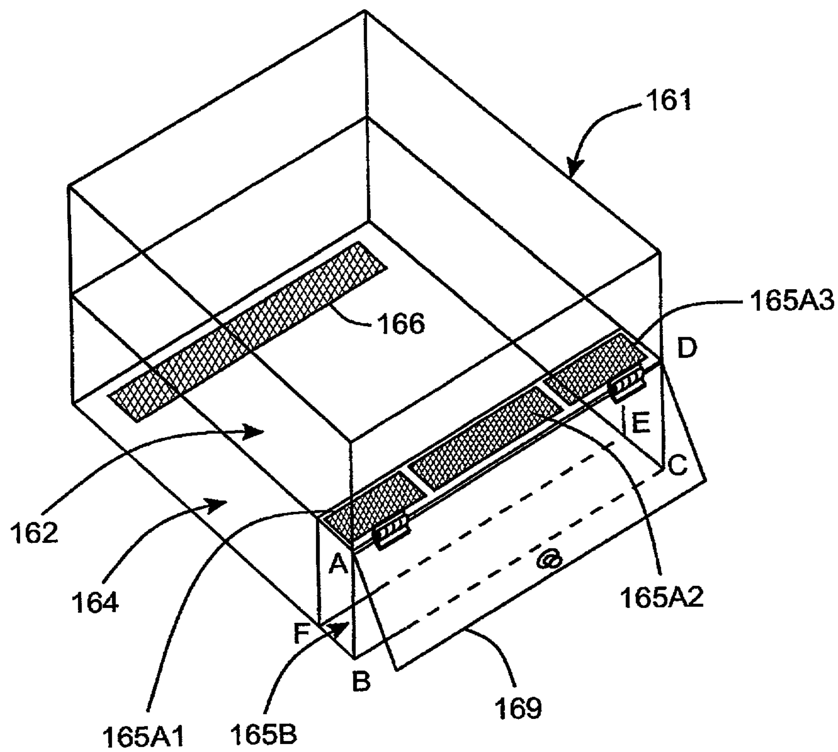
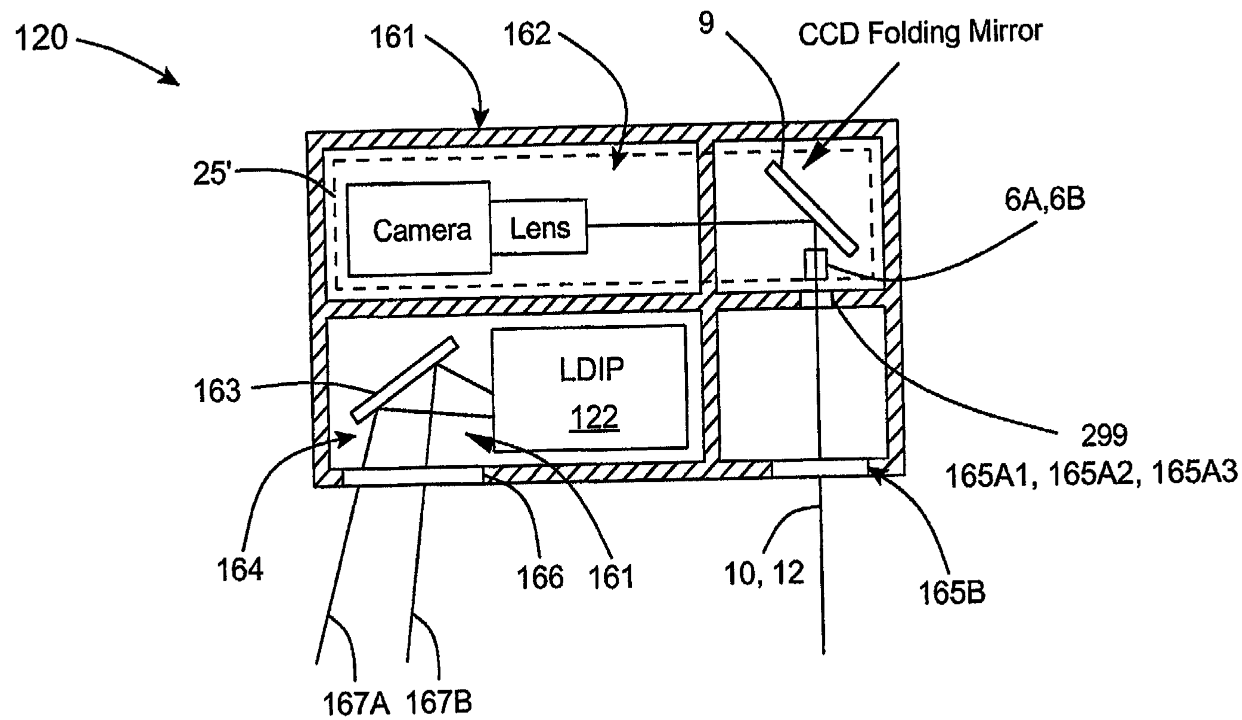


FIG. 12A



120
161
162
9
CCD Folding Mirror
25'
Camera
Lens
6A,6B
163
LDIP
122
299
165A1, 165A2, 165A3
164
166
161
10, 12
165B
167A
167B

FIG. 12B

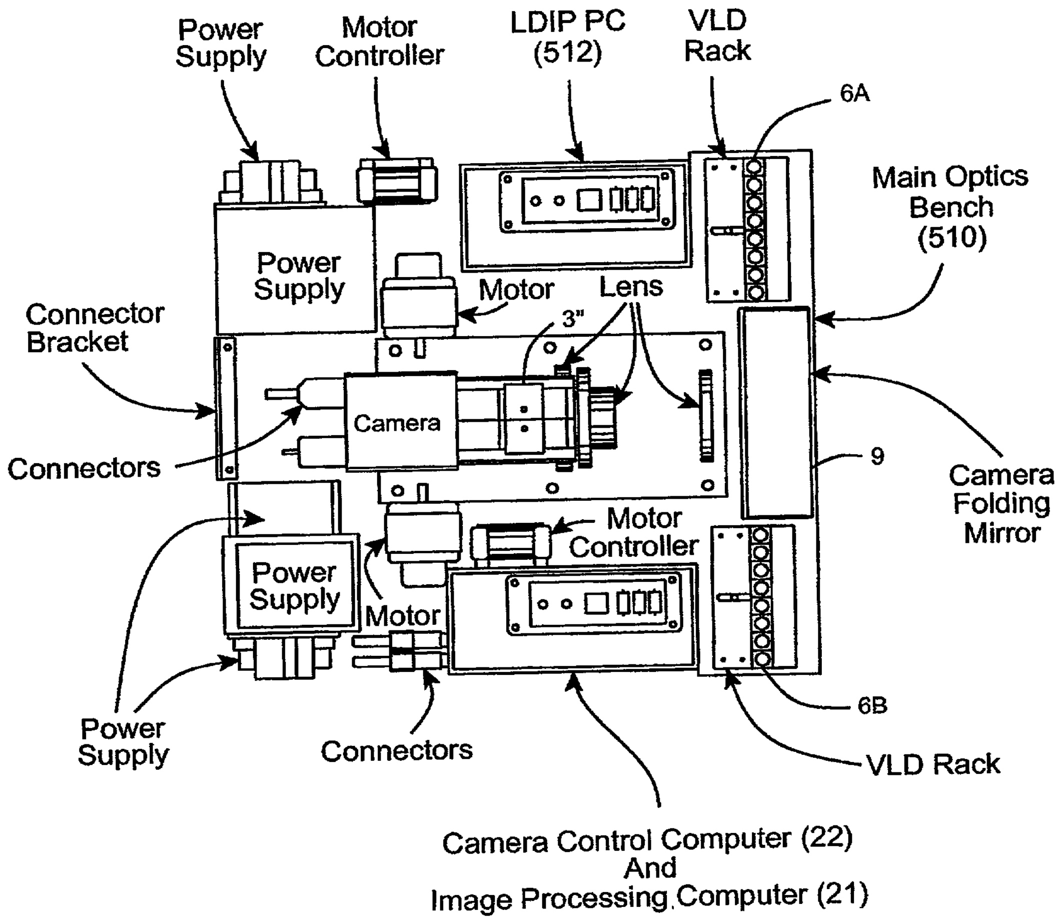

Power Supply
Motor Controller
LDIP PC (512)
VLD Rack
6A
Main Optics Bench (510)
Power Supply
Motor
Lens
3"
Connector Bracket
Camera
Connectors
9
Camera Folding Mirror
Motor Controller
Power Supply
Motor
Power Supply
Connectors
6B
VLD Rack
Camera Control Computer (22)
And
Image Processing Computer (21)

FIG. 12C

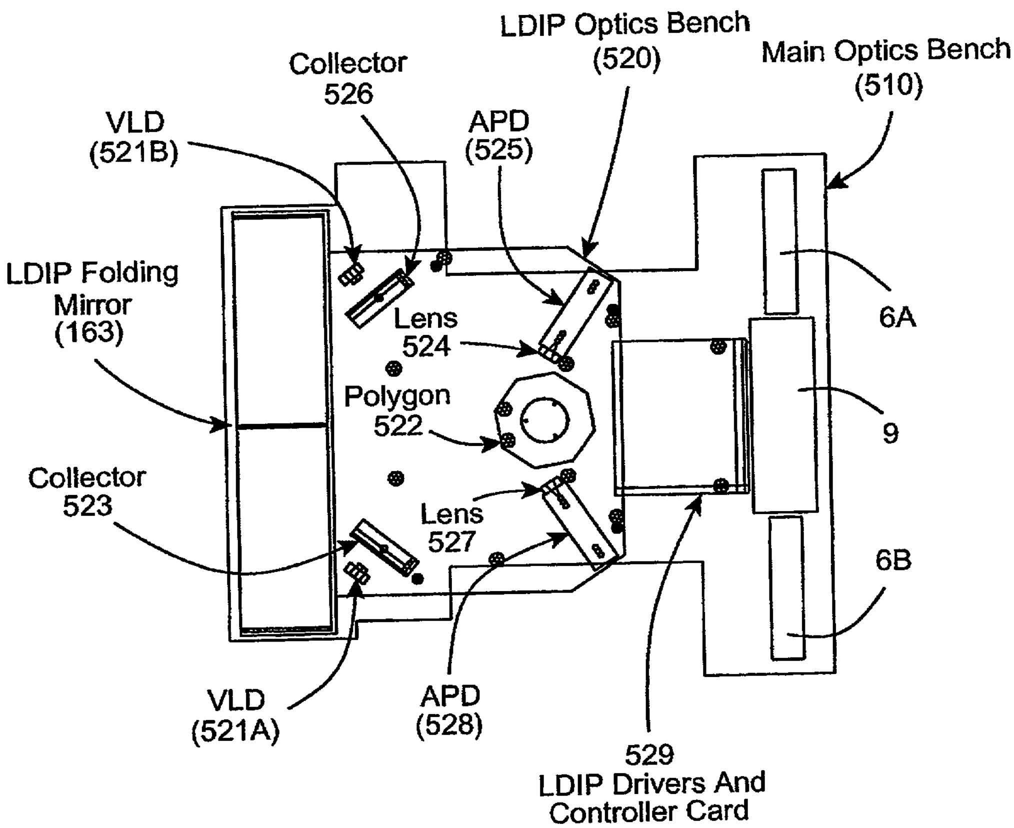
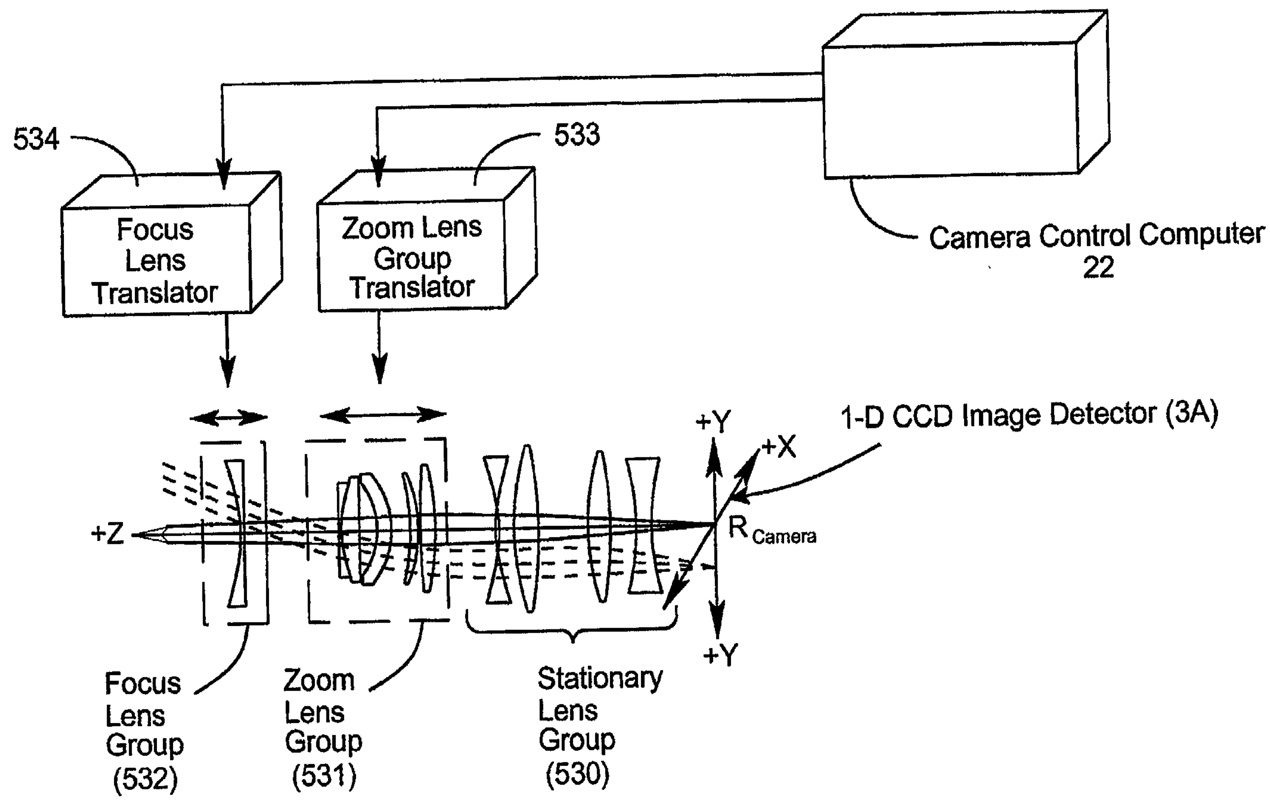

LDIP Optics Bench
(520)
Main Optics Bench
(510)
Collector
526
VLD
(521B)
APD
(525)
LDIP Folding
Mirror
(163)
Lens
524
6A
Polygon
522
9
Collector
523
Lens
527
6B
VLD
(521A)
APD
(528)
529
LDIP Drivers And
Controller Card

FIG. 12D



Main Optics Lens Groups

FIG. 12E

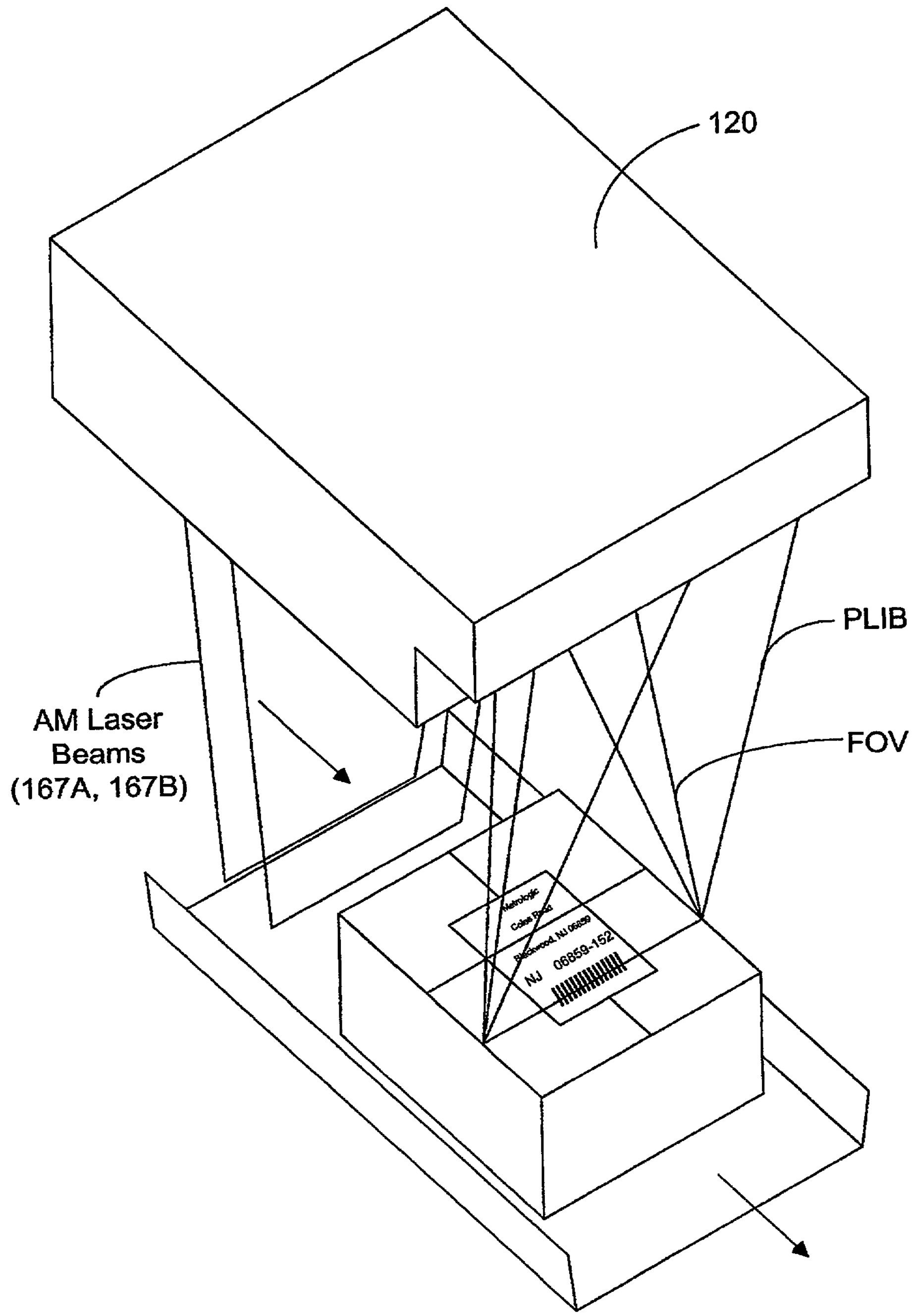

120
AM Laser Beams (167A, 167B)
PLIB
FOV
Metrologic
NJ
06859-152

FIG. 13A

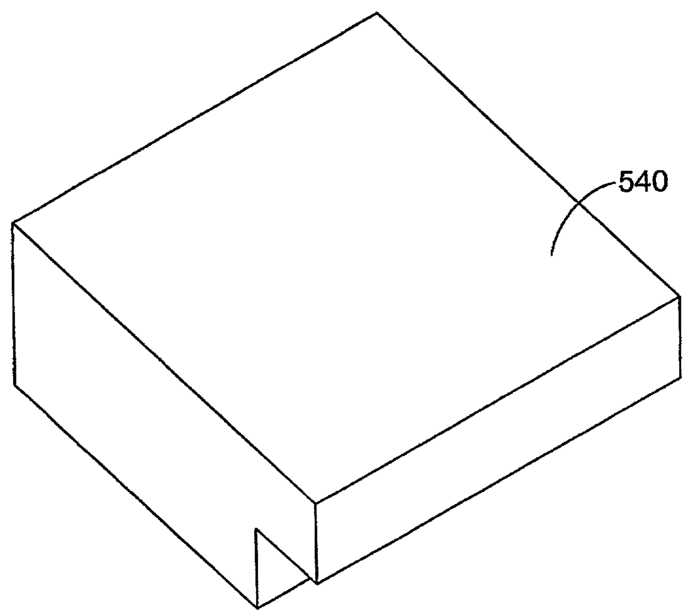


FIG. 13B

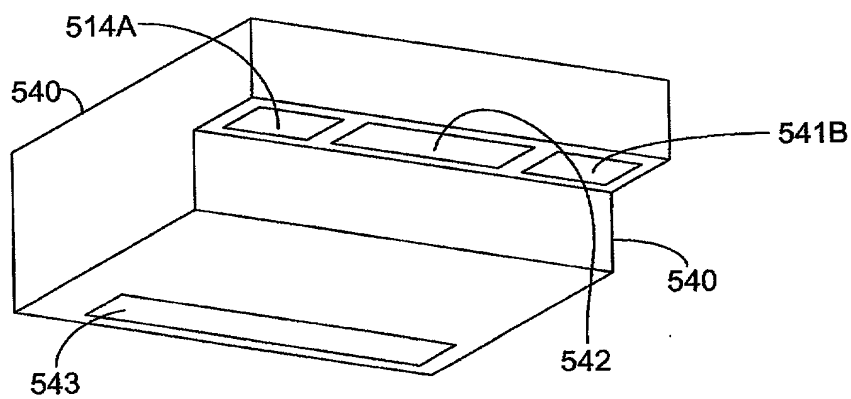


FIG. 13C

PLIIM-BASED PACKAGE IDENTIFICATION AND DIMENSIONING (PID) SYSTEM

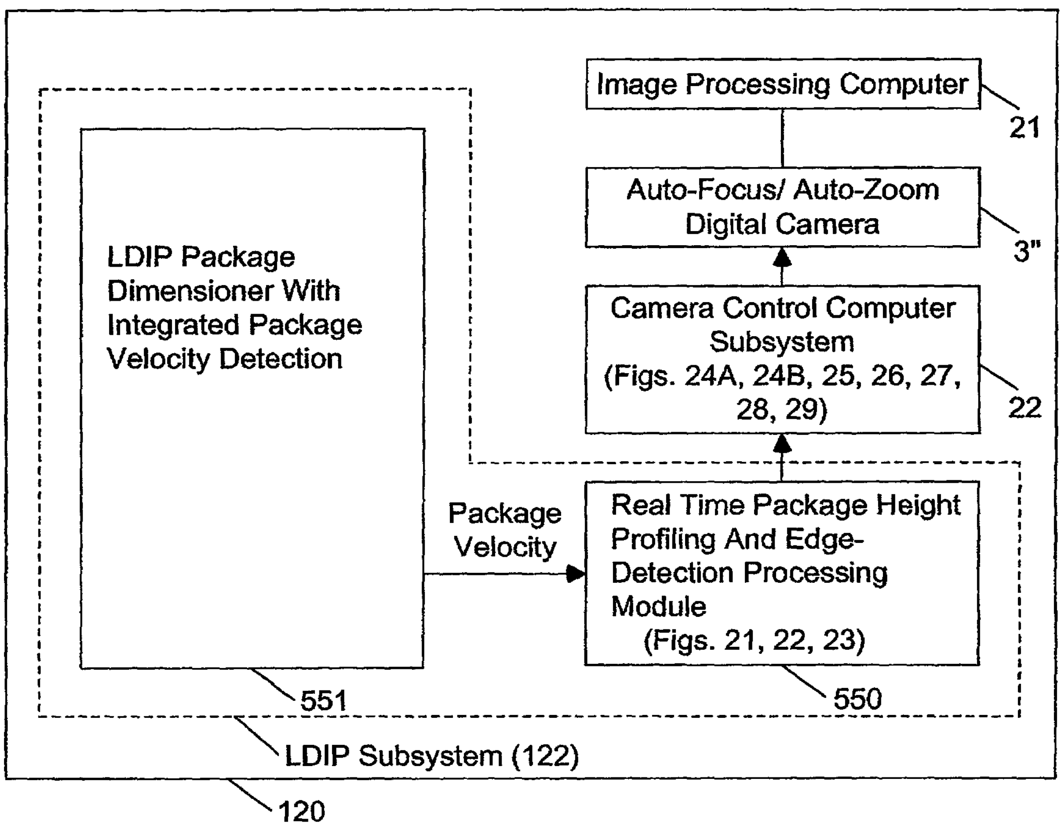


FIG. 14

LDIP REAL-TIME PACKAGE HEIGHT PROFILE AND EDGE DETECTION METHOD

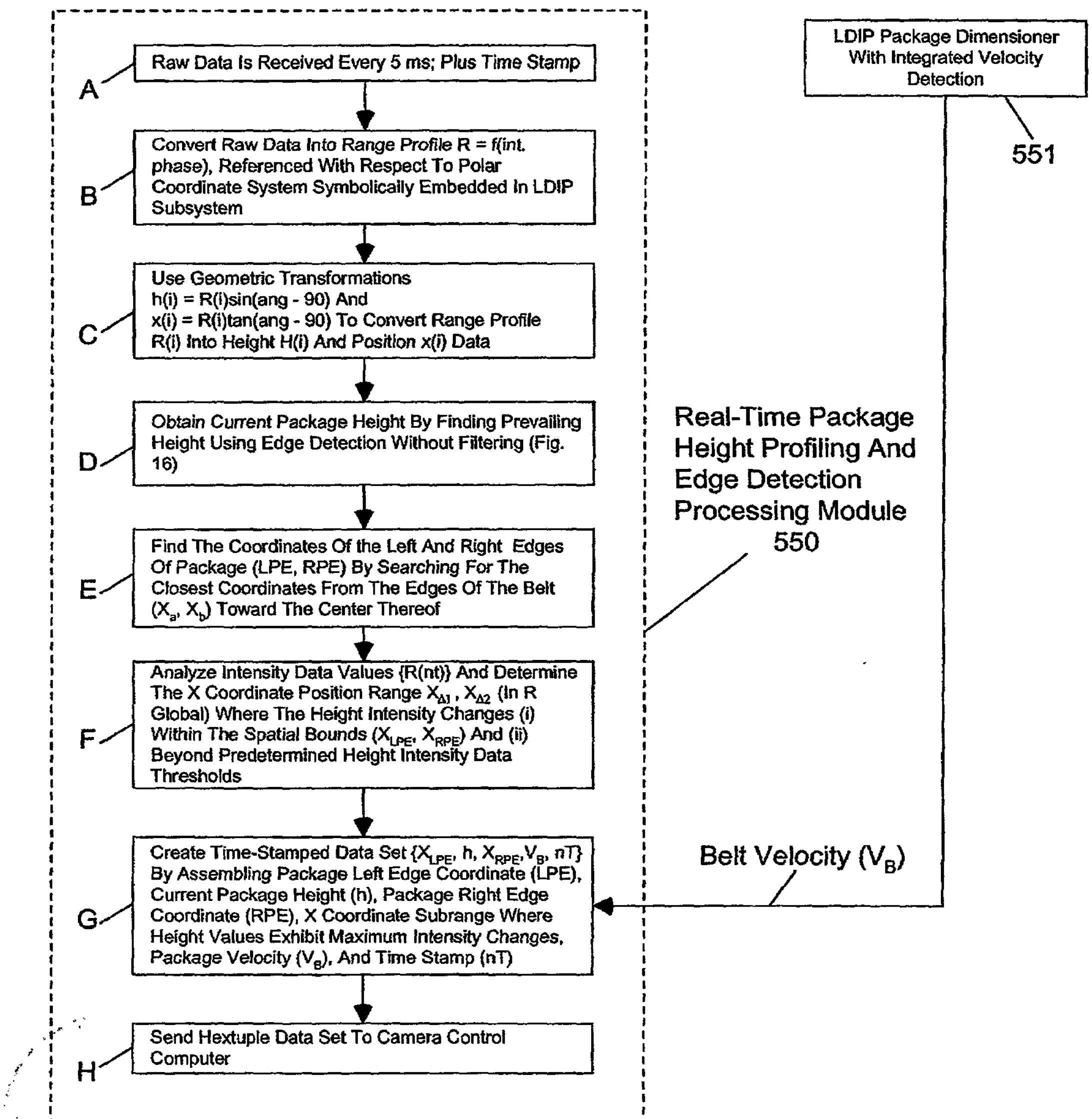
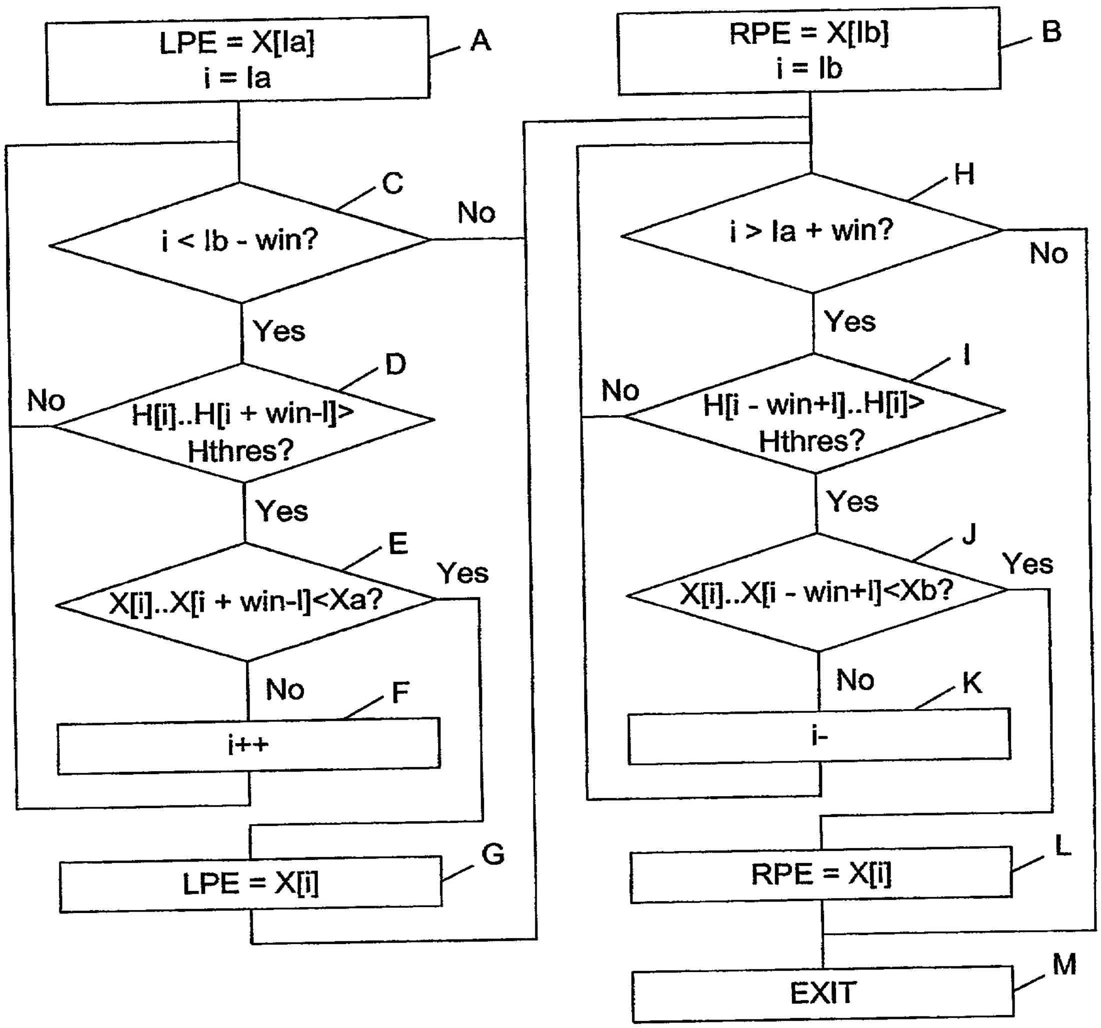


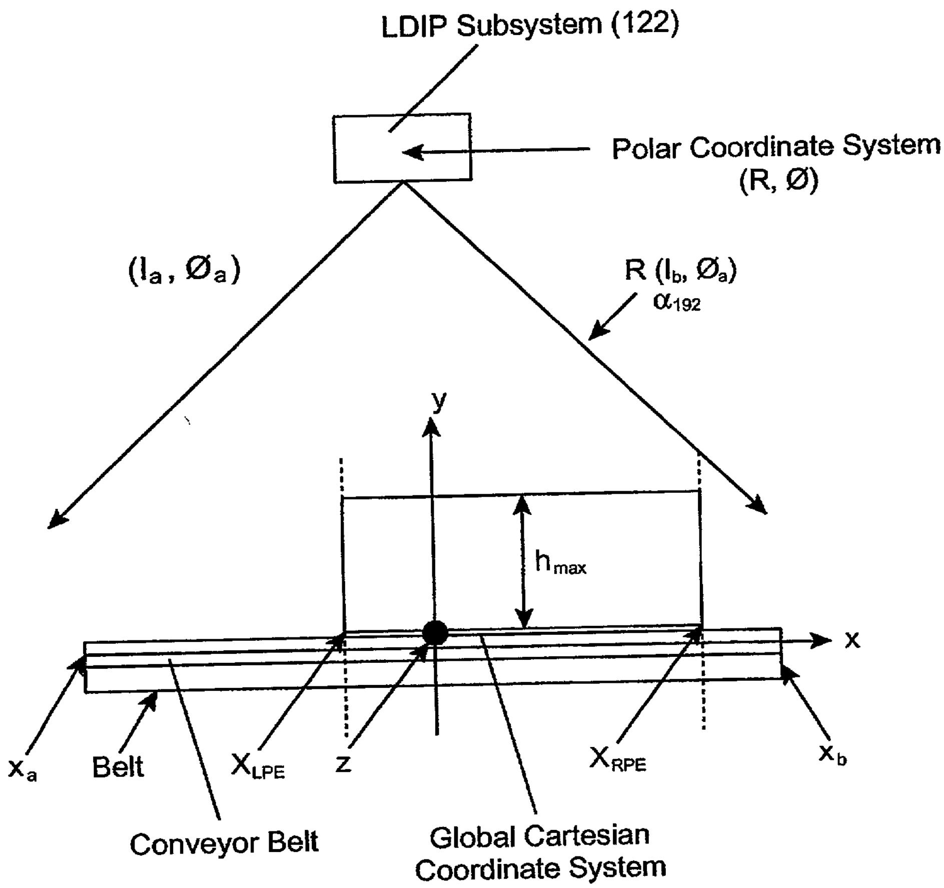
FIG. 15

LDIP REAL-TIME PACKAGE EDGE DETECTION



Xa = Location Of Belt Left Edge; Xb = Location Of Belt Right Edge
Ia = Belt Left Edge Pixel; Ib = Belt Right Edge Pixel
LPE = Left package Edge; RPE = Right Package Edge
H[] = Pixel Height Array; X[] = Pixel Location Array
win = Package detection Window

FIG. 16



LDIP Subsystem (122)
Polar Coordinate System
(R, Ø)
(l_a, $Ø_a$)
R (l_b, $Ø_a$)
α_{192}
y
h_{max}
x
x_a
Belt
X_{LPE}
z
X_{RPE}
x_b
Conveyor Belt
Global Cartesian
Coordinate System

FIG. 17

Information Measured At Scan Angles Before Coordinate Transformations

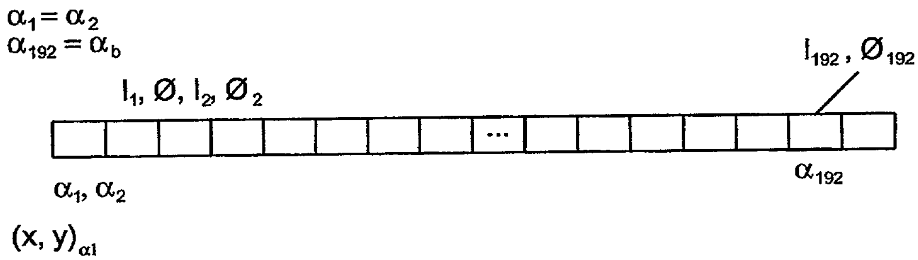


FIG. 17A

Range And Polar Angle Measures Taken At Scan Angle α Before Coordinate Transforms

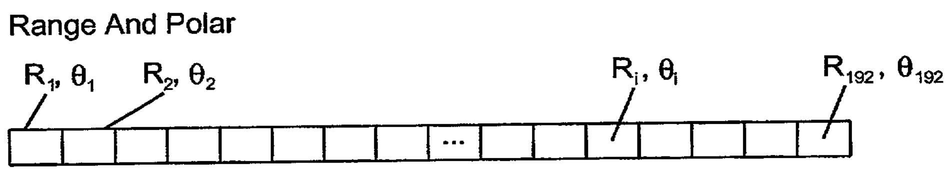


FIG. 17B

Measured Package Height And Position Values After Coordinate Transforms

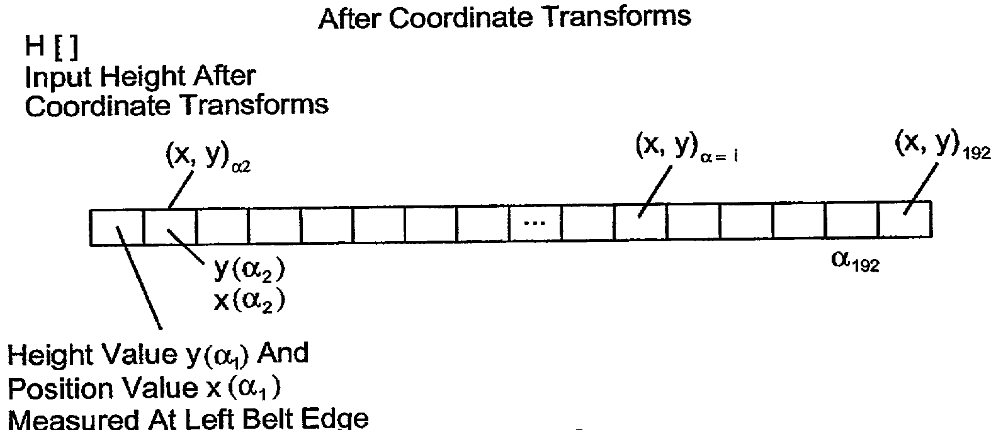


FIG. 17C

CAMERA CONTROL PROCESS CARRIED OUT WITHIN THE CAMERA CONTROL SUBSYSTEM OF EACH OBJECT IDENTIFICATION AND ATTRIBUTE ACQUISITION SYSTEM OF PRESENT INVENTION

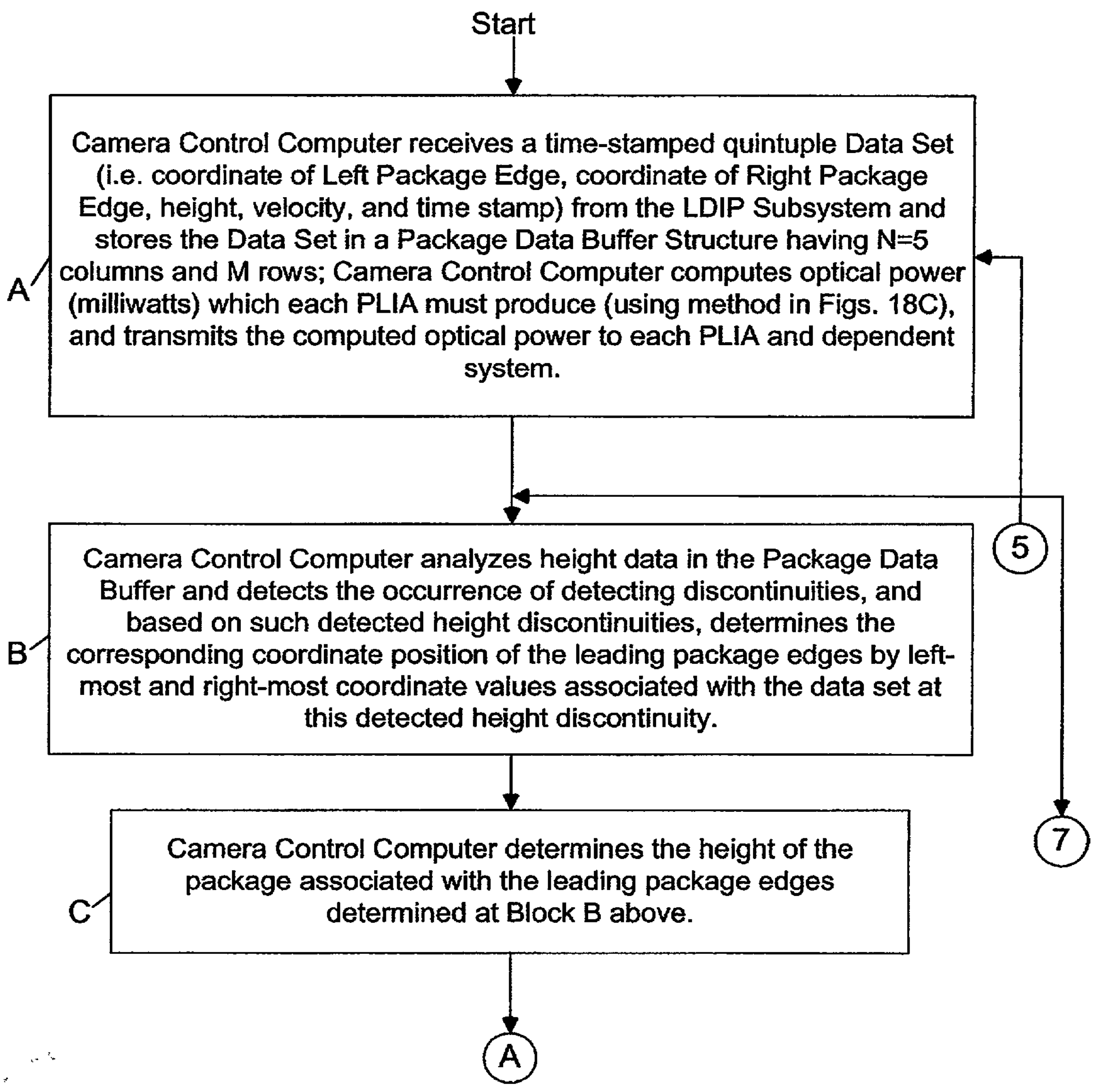


FIG. 18A-1

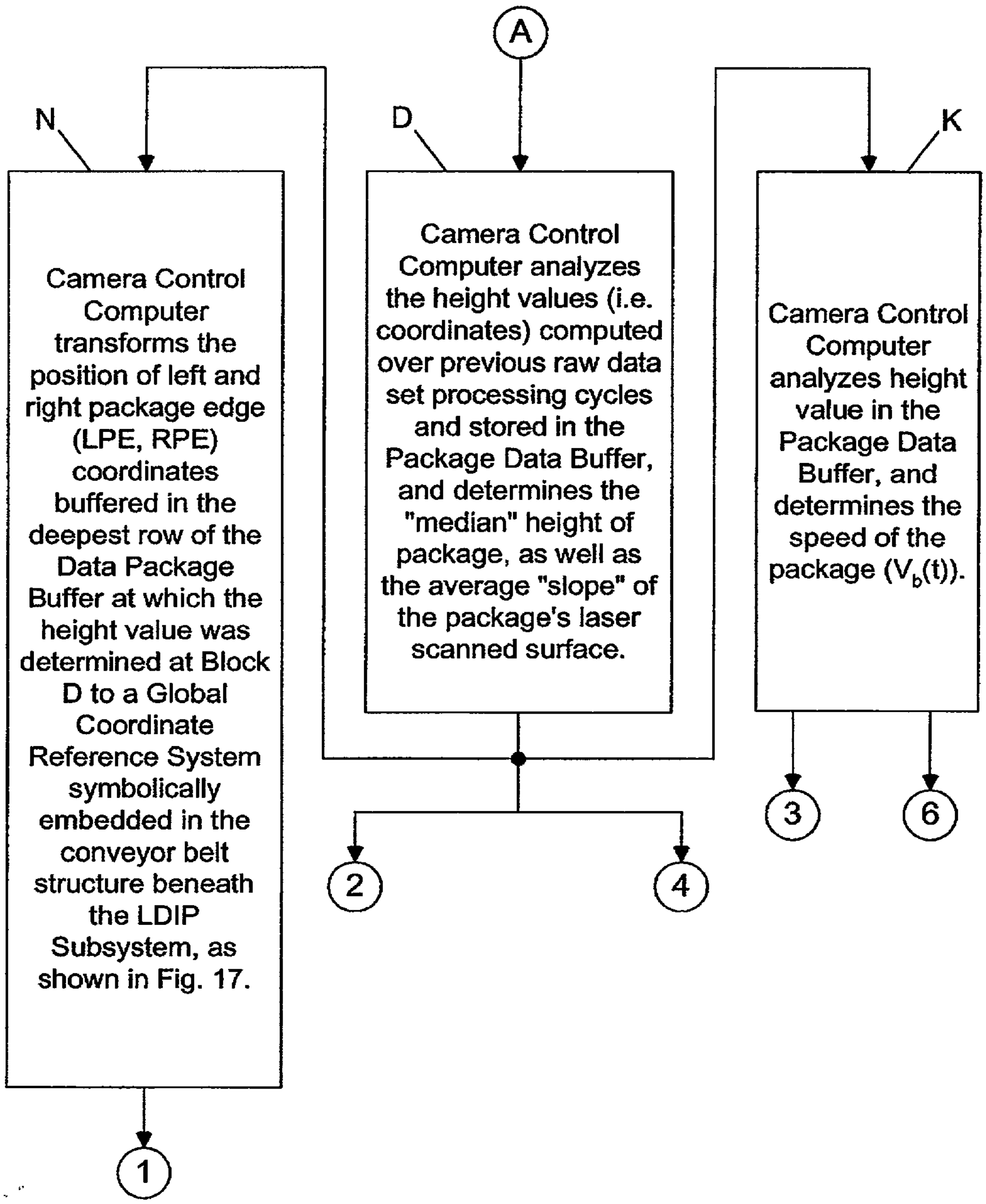

A
N
D
K
Camera Control Computer transforms the position of left and right package edge (LPE, RPE) coordinates buffered in the deepest row of the Data Package Buffer at which the height value was determined at Block D to a Global Coordinate Reference System symbolically embedded in the conveyor belt structure beneath the LDIP Subsystem, as shown in Fig. 17.
Camera Control Computer analyzes the height values (i.e. coordinates) computed over previous raw data set processing cycles and stored in the Package Data Buffer, and determines the "median" height of package, as well as the average "slope" of the package's laser scanned surface.
Camera Control Computer analyzes height value in the Package Data Buffer, and determines the speed of the package ($V_b(t)$).
1
2
4
3
6

FIG. 18A-2

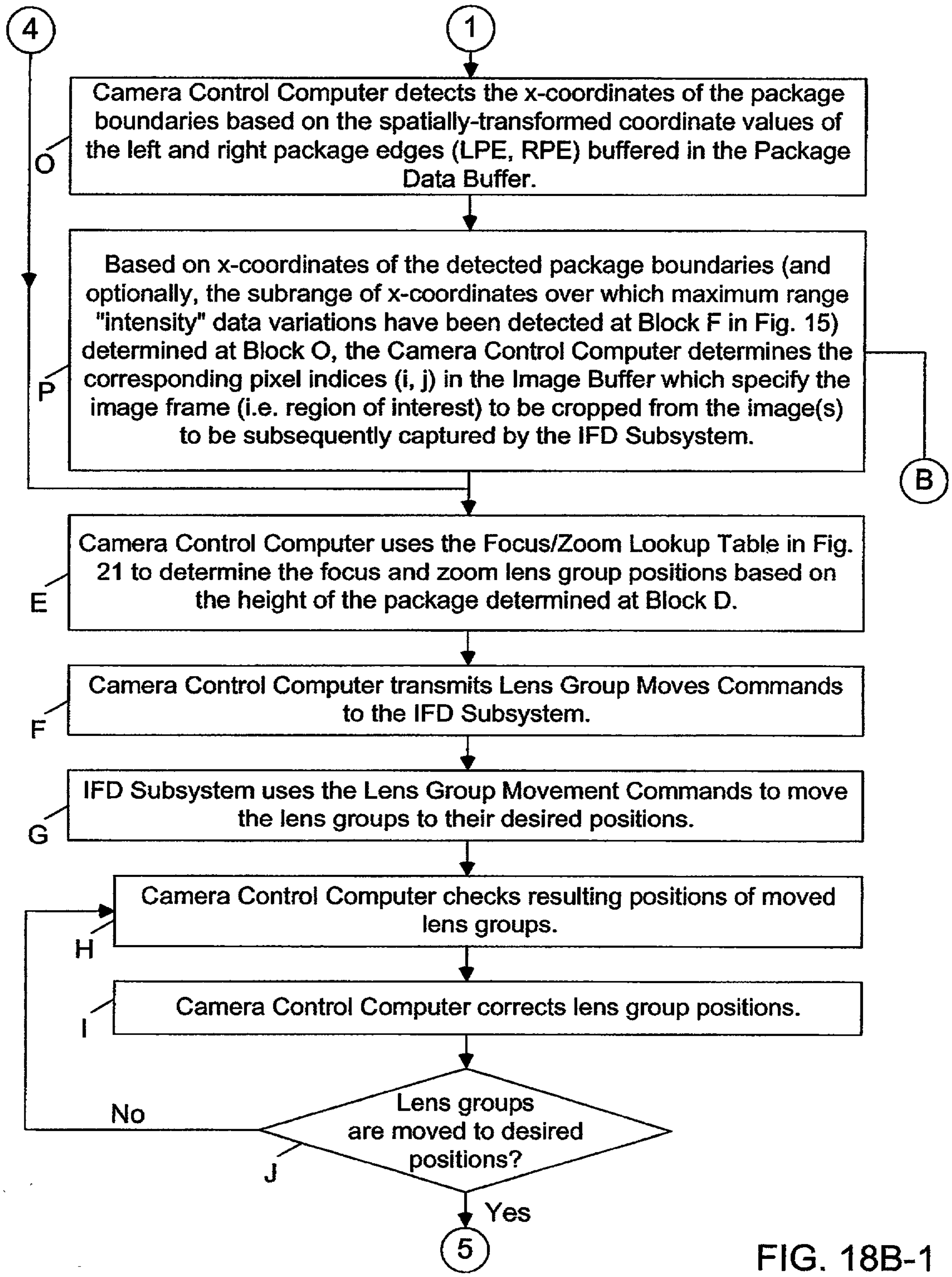

4
1
Camera Control Computer detects the x-coordinates of the package boundaries based on the spatially-transformed coordinate values of the left and right package edges (LPE, RPE) buffered in the Package Data Buffer.
O
Based on x-coordinates of the detected package boundaries (and optionally, the subrange of x-coordinates over which maximum range "intensity" data variations have been detected at Block F in Fig. 15) determined at Block O, the Camera Control Computer determines the corresponding pixel indices (i, j) in the Image Buffer which specify the image frame (i.e. region of interest) to be cropped from the image(s) to be subsequently captured by the IFD Subsystem.
P
B
Camera Control Computer uses the Focus/Zoom Lookup Table in Fig. 21 to determine the focus and zoom lens group positions based on the height of the package determined at Block D.
E
Camera Control Computer transmits Lens Group Moves Commands to the IFD Subsystem.
F
IFD Subsystem uses the Lens Group Movement Commands to move the lens groups to their desired positions.
G
Camera Control Computer checks resulting positions of moved lens groups.
H
Camera Control Computer corrects lens group positions.
I
Lens groups are moved to desired positions?
J
No
Yes
5

FIG. 18B-1

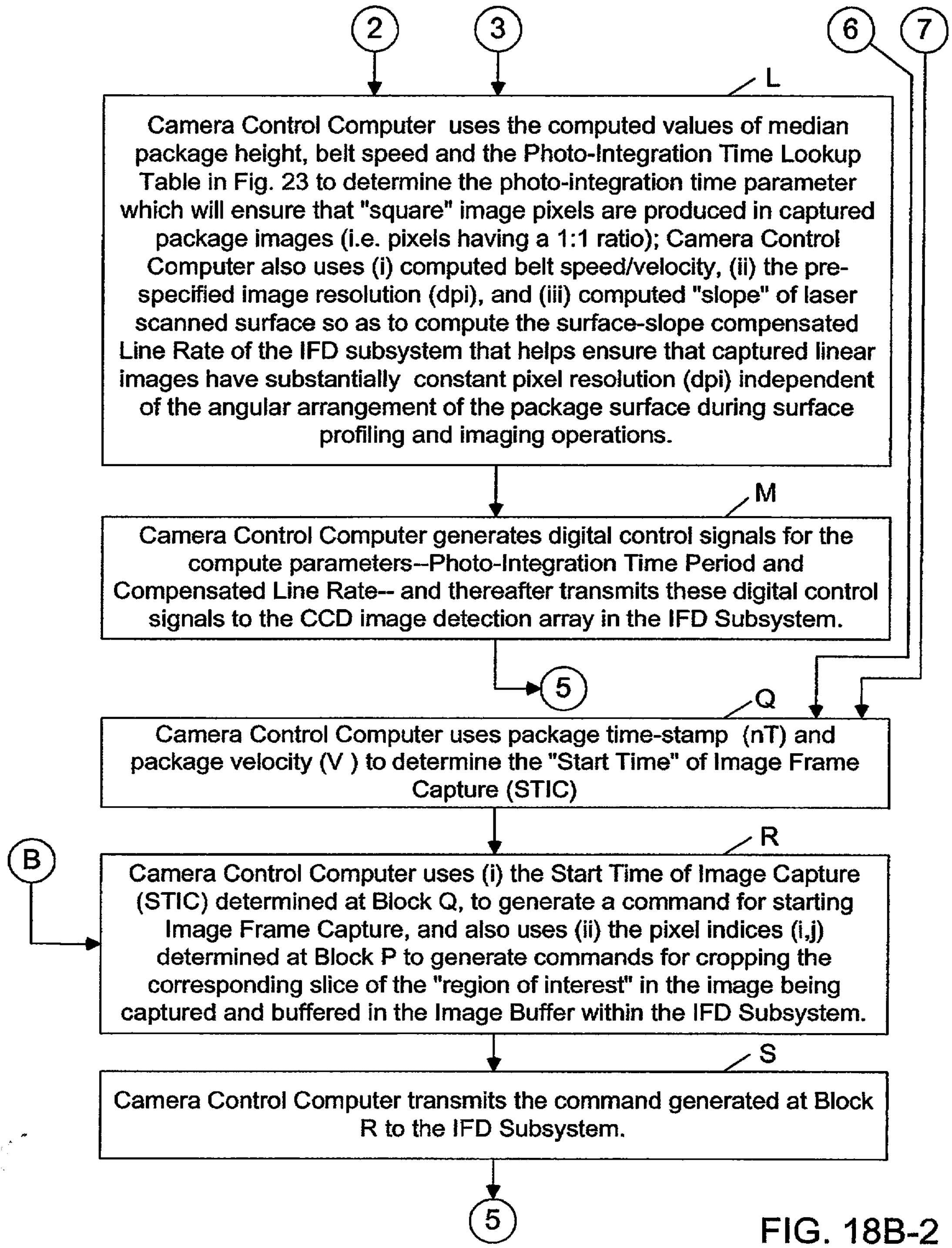

2
3
6
7
L
Camera Control Computer uses the computed values of median package height, belt speed and the Photo-Integration Time Lookup Table in Fig. 23 to determine the photo-integration time parameter which will ensure that "square" image pixels are produced in captured package images (i.e. pixels having a 1:1 ratio); Camera Control Computer also uses (i) computed belt speed/velocity, (ii) the pre-specified image resolution (dpi), and (iii) computed "slope" of laser scanned surface so as to compute the surface-slope compensated Line Rate of the IFD subsystem that helps ensure that captured linear images have substantially constant pixel resolution (dpi) independent of the angular arrangement of the package surface during surface profiling and imaging operations.
M
Camera Control Computer generates digital control signals for the compute parameters--Photo-Integration Time Period and Compensated Line Rate-- and thereafter transmits these digital control signals to the CCD image detection array in the IFD Subsystem.
5
Q
Camera Control Computer uses package time-stamp (nT) and package velocity (V) to determine the "Start Time" of Image Frame Capture (STIC)
B
R
Camera Control Computer uses (i) the Start Time of Image Capture (STIC) determined at Block Q, to generate a command for starting Image Frame Capture, and also uses (ii) the pixel indices (i,j) determined at Block P to generate commands for cropping the corresponding slice of the "region of interest" in the image being captured and buffered in the Image Buffer within the IFD Subsystem.
S
Camera Control Computer transmits the command generated at Block R to the IFD Subsystem.
5

FIG. 18B-2

METHOD OF COMPUTING OPTICAL OUTPUT POWER FROM LASER DIODES IN A PLANAR LASER ILUMINATION ARRAY (PLIA) FOR CONTROLLING THE CONSTANT WHITE-LEVEL IN IMAGE PIXELS CAPTURED BY A PLIIM-BASED LINEAR IMAGER

A

Compute the Line Rate of a Linear Image Detection Array (dots/sec) based on computed Belt Velocity (inches/sec) and constant Image Resolution (dots/inch) desired, using equation:

Line Rate = (Belt Velocity) x (Image Resolution)

↓

B

Compute the Photo-integration Time ΔT of the Linear Image Detection Array based on the computed Line Rate using the formula:

Photo-integration Time Period = 1/Line Rate

↓

A

FIG. 18C1

A

Compute the Optical Power (milliwatts) of each PLIA based on the computed Photo-integration Time Period (ΔT) using the following formula:

$$\text{Optical Power of VLD (milliwatts)} = \frac{\text{constant}}{\text{Photo-integration Time Period } \Delta T}$$

FIG. 18C2

METHOD OF COMPUTING COMPENSATED LINE RATE FOR CORRECTING VIEWING-ANGLE DISTORTION OCCURING IN IMAGES OF OBJECT SURFACES CAPTURED AS OBJECT SURFACES MOVE PAST A PLIIM-BASED LINEAR IMAGER AT NON-ZERO SKEWED ANGLE

A

Compute the Line Rate of Linear Image Detection Array (dots/sec) based on computed Belt Velocity (inches/sec) and constant Image Resolution (dots/inch) desired, using equation:

Line Rate = (Belt Velocity) x (Image Resolution)

B

Compute the Line Rate Compensation factor cosine (θ or Ø), where θ and Ø is defined in Figs. 18E1 and 18E2, respectively, as the computed average scope of the packages surface (i.e laser scanned by the AM laser beams powered by the LDIP subsystem) and is computed at Block D in Fig. 18A.

C

Compute the Compensated Line Rate for the IFD (i.e. camera) Subsystem using the equation:

Compensated Line Rate = (Line Rate) x Cos(θ))

FIG. 18D

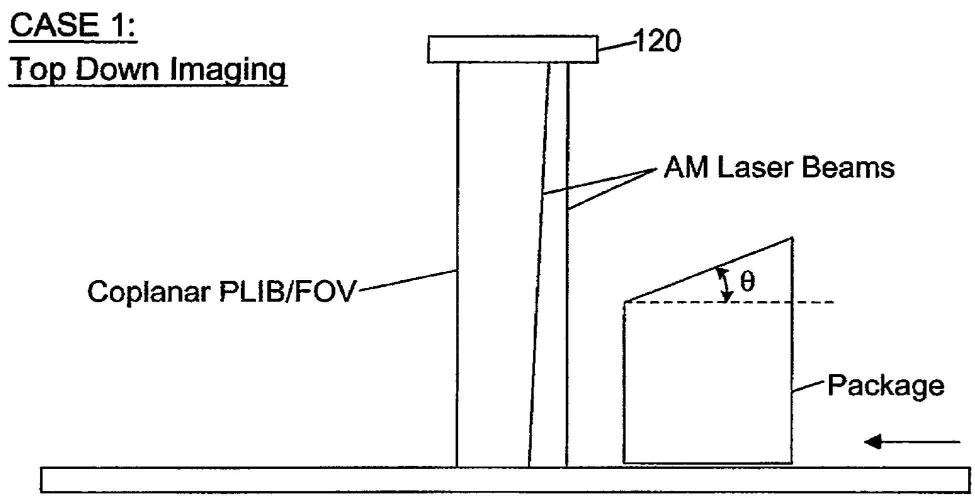


FIG. 18E1

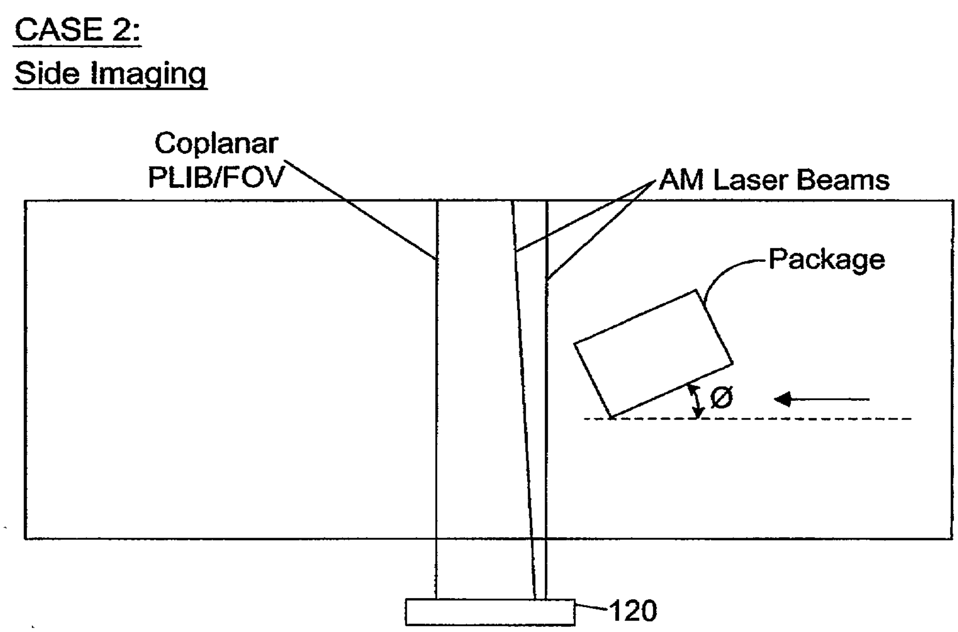


FIG. 18E2

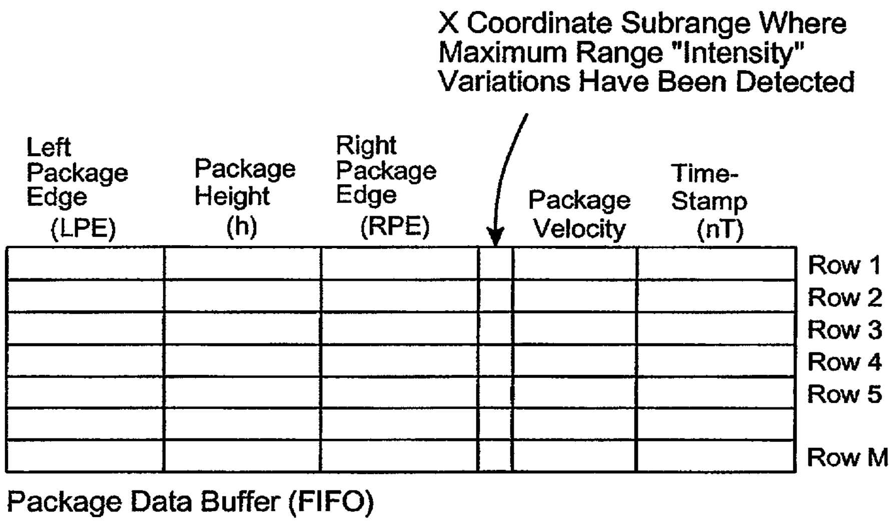

X Coordinate Subrange Where Maximum Range "Intensity" Variations Have Been Detected
Left Package Edge (LPE)
Package Height (h)
Right Package Edge (RPE)
Package Velocity
Time-Stamp (nT)
Row 1
Row 2
Row 3
Row 4
Row 5
Row M
Package Data Buffer (FIFO)

FIG. 19

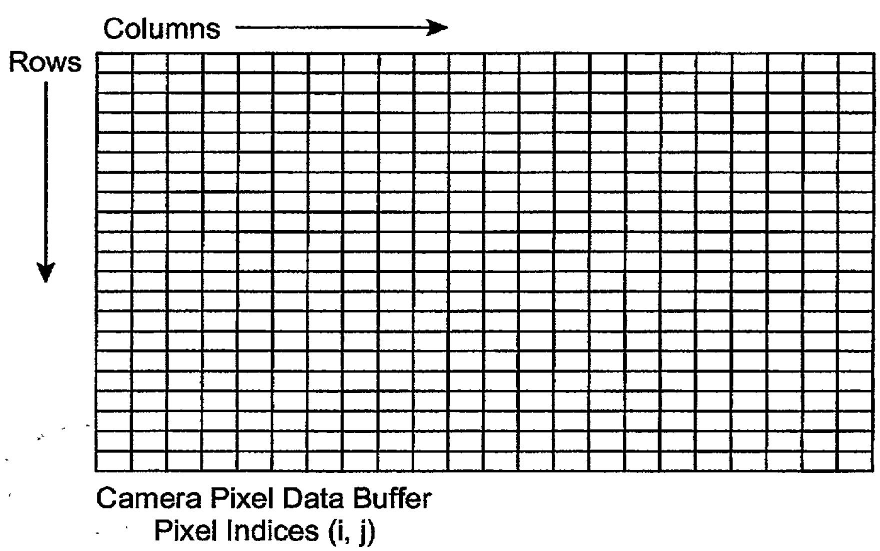

Columns
Rows
Camera Pixel Data Buffer
Pixel Indices (i, j)

FIG. 20

Zoom And Focus Lens Group Position

Look-Up Table

Distance From Camera H (mm)		Zoom Group Distance (mm) Y (Zoom)	Focus Group Distance (mm) Y (Focus)
	1000	21.57489228	2.47E-05
	1100	19.38089696	10.99009783
	1200	17.10673434	20.65783177
	1300	14.77137314	29.10917002
(Use Interpolation	1400	12.39153565	36.47312595
Techniques For	1500	9.979114358	42.87845436
Working Distances	1600	7.540639114	48.44003358
Between Listed	1700	5.078794775	53.25495831
Points In Table)	1800	2.595989366	57.40834303
	1900	0.099972739	60.98883615

FIG. 21

* Note: The focal distance and zoom (eff. focal length) of camera lens are coupled (inter-dependant) in this commercial embodiment.

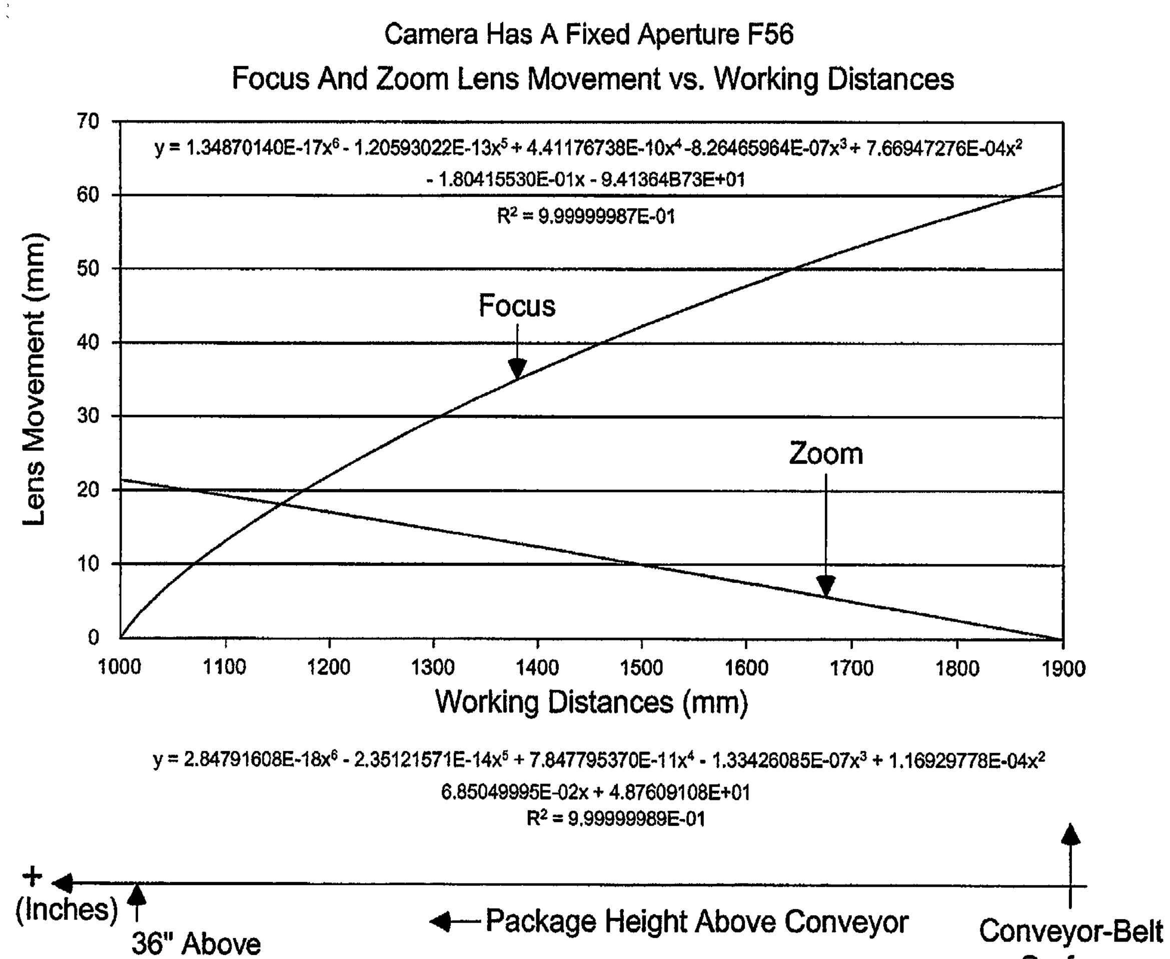


FIG. 22A

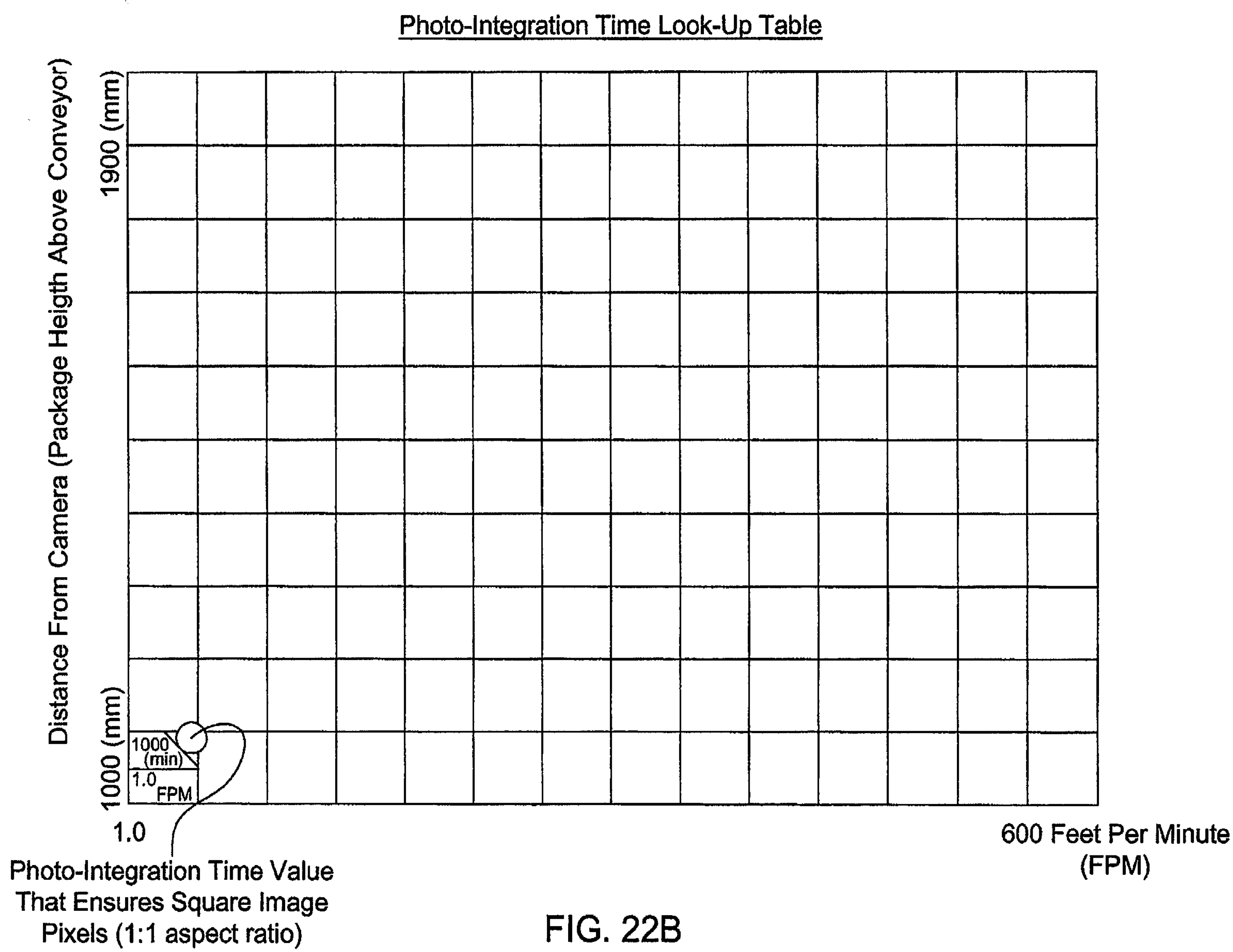
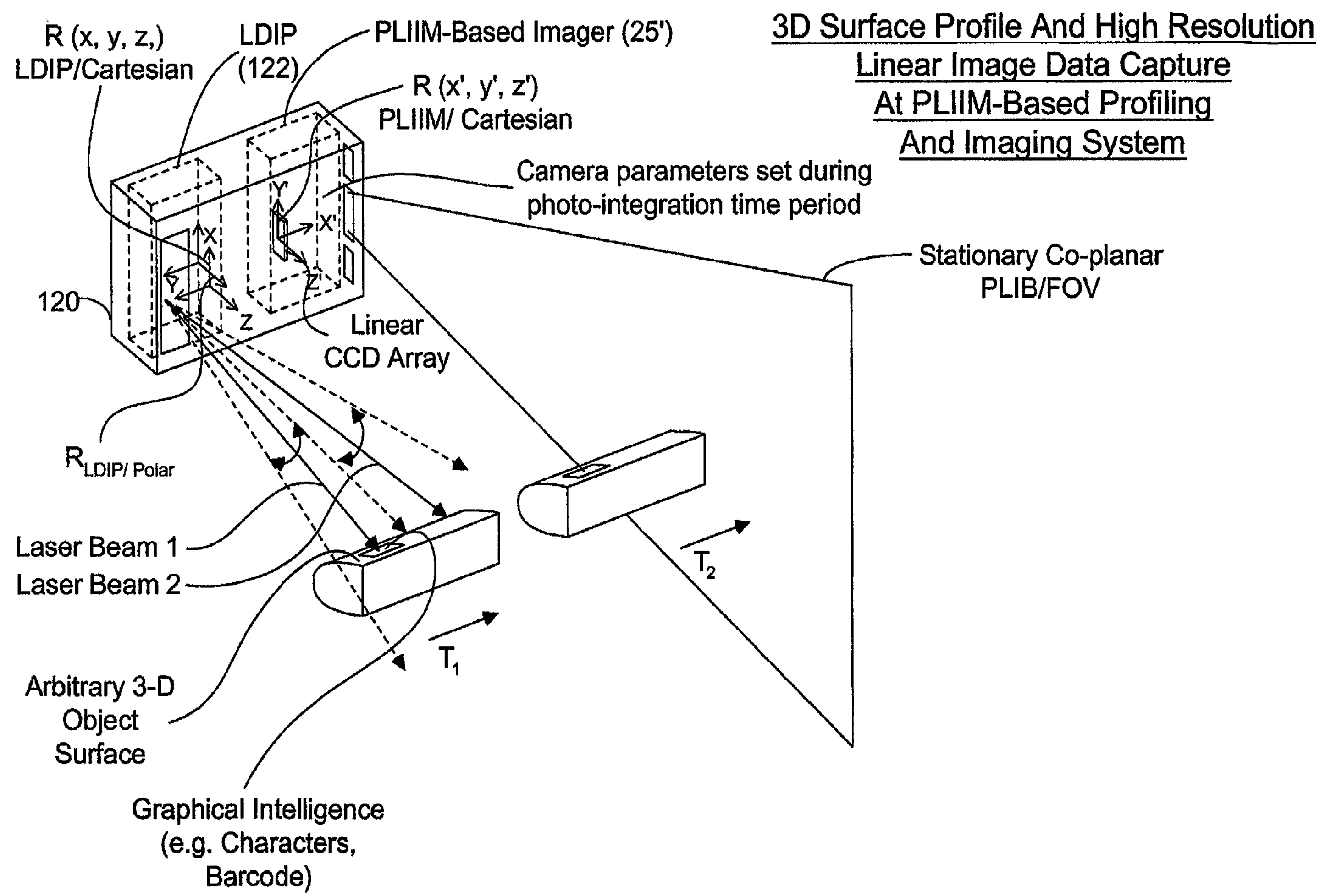


Photo-Integration Time Look-Up Table
Distance From Camera (Package Heigth Above Conveyor)
1900 (mm)
1000 (mm)
1000 (min)
1.0 FPM
1.0
600 Feet Per Minute (FPM)
Photo-Integration Time Value That Ensures Square Image Pixels (1:1 aspect ratio)

FIG. 22B



3D Surface Profile And High Resolution
Linear Image Data Capture
At PLIIM-Based Profiling
And Imaging System
R (x, y, z,)
LDIP/Cartesian
LDIP
(122)
PLIIM-Based Imager (25')
R (x', y', z')
PLIIM/ Cartesian
Camera parameters set during
photo-integration time period
Stationary Co-planar
PLIB/FOV
120
Linear
CCD Array
$R_{LDIP/ Polar}$
Laser Beam 1
Laser Beam 2
Arbitrary 3-D
Object
Surface
Graphical Intelligence
(e.g. Characters,
Barcode)
T_1
T_2

FIG. 23A

Geometrical Modelling Of Arbitrary 3-D Object Surface At Image Processing Computer

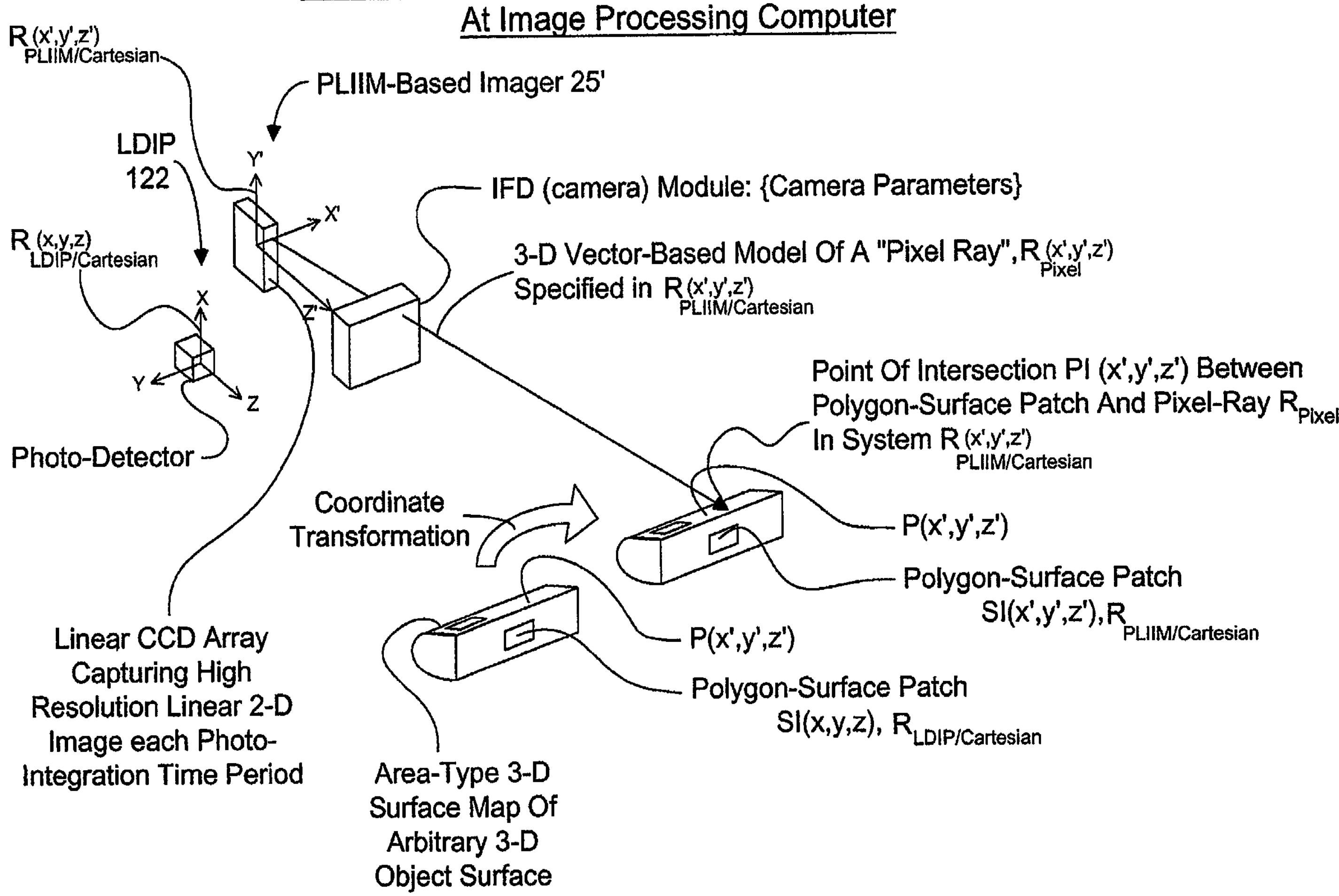


FIG. 23B

METHOD OF AND APPARATUS FOR PERFORMING AUTOMATIC RECOGNITION OF GRAPHICAL INTELLIGENCE CONTAINED IN 2-D IMAGES CAPTURED FROM ARBITARY 3-D OBJECT SURFACES

STEP 1: At the unitary PLIIM-based object imaging and profiling system, use the laser doppler imaging and profiling (LDIP) subsystem employed therein to (i) consecutively capture a series of linear 3-D surface profile maps on a targeted arbitrary (e.g. non-planar or planar) 3-D object surface bearing forms of graphical intelligence and (ii) measure the velocity of the arbitrary 3-D object surface, wherein the polar coordinates of each point in the captured linear 3-D surface profile map are specified in a local polar coordinate system $R_{LDIP/polar}$, symbolically embedded within the LDIP subsystem.

A

↓

STEP 2: At the unitary PLIIM-based object imaging and profiling system, use coordinate transforms to automatically convert the polar coordinates of each point $p(\alpha, R)$ in the captured linear 3-D surface profile map into x,y, z Cartesian coordinates specified as $p(x,y,z)$ in a local Cartesian coordinate system $R_{LDIP/Cartesian}$, symbolically embedded within the LDIP subsystem.

B

↓

STEP 3: At the unitary PLIIM-based object imaging and profiling system, use the PLIIM-based imager employed therein to consecutively capture high-resolution linear 2-D images of the arbitrary 3-D object surface bearing forms of graphical intelligence (e.g. symbol character strings), wherein (i) the x', y' coordinates of each pixel in each said captured high-resolution linear 2-D image is specified in local Cartesian coordinate system $R_{PLIIM/Cartesian}$ symbolically embedded within the PLIIM-based imager, and (ii) the intensity value of the pixel $I(x',y')$ is associated with the x', y' Cartesian coordinates of the image detection element in the linear image detection array at which the pixel is detected, and (iii) wherein also the planar laser illumination beam (PLIB) of the PLIIM-based imager is spaced from the amplitude modulated (AM) laser scanning beam of the LDIP subsystem is about D centimeters.

C

↓

A

FIG. 23C1

A

STEP 4: At the unitary PLIIM-based object imaging and profiling system, capture and buffer the camera (IFD) parameters used to form and detect each linear high-resolution 2-D image captured during the corresponding photo-integration time period ΔT_K , by the PLIIM-based imager.

D

STEP 5: At the end of each photo-integration time period ΔT_K, use the unitary PLIIM-based object imaging and profiling system to transmit the following information elements to the Image Processing Computer for data storage and subsequent information processing:

(1) the converted coordinates x, y, z, of each point in the linear 3-D surface profile map of the arbitrary 3-D object surface captured during photo-integration time period ΔT_K;

(2) the measured velocity(ies) of the arbitrary 3-D object surface during photo-integration time period ΔT_K;

(3) the x', y' coordinates and intensity value I(x',y') of each pixel in each high- resolution linear 2-D image captured during photo-integration time period DTk and specified in the local Cartesian coordinate system $R_{PLIIM/Cartesian}$; and

(4) the captured camera (IFD) parameters used to form and detect each linear high-resolution 2-D image captured during the photo-integration time period ΔT_K

E

STEP 6: At the Image Processing Computer, receive the data elements transmitted from the PLIIM-based profiling and imaging system durin Step 5, buffer data elements (1) and (2) in a first FIFO buffer memory structure, and data elements (3) and (4) in a second FIFO buffer memory structure.

F

B

FIG. 23C2

B

STEP 7: At the Image Processing Computer, use the x,y, z coordinates associated with a consecutively captured series of linear 3-D surface profile maps (i.e. stored in first FIFO memory storage structure)in order to construct a 3-D polygon-mesh surface representation of said arbitrary 3-D object surface, represented by S_{LDIP} (x,y,z) and having (i) vertices specified by x,y, z in local coordinate reference system $R_{PLIIM/Cartesian}$, and (ii) planar polygon surface patches s (x,y,z) and being defined by a set of said vertices. G

STEP 8: At the Image Processing Computer, convert the x',y',z' coordinates of each vertex in the 3-D polygon-mesh surface representation into the local Cartesian coordinate reference system $R_{PLIIM/Cartesian}$ symbolically embedded within the PLIIM-based imager. H

STEP 9: At the Image Processing Computer, specify the x',y', z' coordinates of each i-th planar polygon surface patch s(x,y,z) represented in the local Cartesian coordinate reference system $R_{PLIIM/Cartesian}$, so as to produce a set of corresponding polygon surface patch $\{s_i(x',y',z')\}$ represented in system $R_{PLIIM/Cartesian}$ I

STEP 10: At the Image Processing Computer, for a selected linear high-resolution 2-D image captured at photo-integration time period ΔT_K, and spatially corresponding to one of the linear 3-D surface profile maps employed at Step 7, use the camera (IFD) parameters used and recorded (i.e. captured) during the corresponding photo-integration time period in order to construct a 3-D vector-based "pixel ray" model specifying the optical formation of each pixel in the linear 2-D image, wherein a pixel ray reflected off a point on the arbitrary 3-D object surface is focused through the camera's image formation optics (i.e. configured by the camera parameters) and is detected at the pixel's detection element in the linear image detection array of the IFD (camera) subsystem. J

C

FIG. 23C3

C

STEP 11: At the Image Processing Computer, for each laser beam ray (producing one of the pixels in said selected linear 2-D image), (i) determine which polygon surface patch $s_i(x, y, z)$ the pixel ray intersects, (ii) compute the x,y, z coordinates of the point of intersection (POI) between the pixel ray and the polygon surface patch represented in Cartesian coordinate reference system $R_{PLIIM/Cartesian}$, and (iii) designate the computed set of points of intersection as $\{p_i(x,y,z)\}$. K

STEP 12: At the Image Processing Computer, for each laser beam ray passing through a determined polygon surface patch s(x',y', z') at a computed point of intersection $p_i(x, y, z)$, assign the intensity value I(x',y') of the pixel ray to the x', y', z' coordinates of the point of intersection, thereby producing a linear high-resolution 3-D image comprising a 2-D array of pixels, each said pixel pixel having as its attributes (i) an Intensity value I(x',y',z') and (ii) coordinates x', y', z' specified in the local Cartesian coordinate reference system $R_{PLIIM/Cartesian}$. L

STEP 13: Put the computed linear high-resolution 3-D image in a third FIFO memory storage structure in the image processing computer. M

STEP 14: Repeat Steps 1-6 to update the first and second FIFO data queues maintained in the image processing computer, and Steps 7-13 to update the consecutively computed linear high-resolution 3-D image stored in the third FIFO memory storage structure. N

STEP 15: Assemble in an image buffer in the image processing computer, a set of consecutively computed linear high-resolution 3-D images retrieved from the third FIFO data storage device so as to construct an "area-type" high-resolution 3-D image of said arbitrary 3-D object surface. O

D

FIG. 23C4

D

STEP 16: At the Image Processing Computer, map the intensity value I(x', y', z') of each pixel in the computed area-type 3-D image onto the x',y',z' coordinates of the points on a uniformly-spaced apart "grid" positioned perpendicular to the optical axis of the camera subsystem (i.e. to model the 2-D planar substrate on which the forms of graphical intelligence was originally rendered), wherein said mapping process involves using an intensity weighing function based on the x', y', z' coordinate values of each pixel in the area-type high-resolution 3-D image, thereby producing an area-type high-resolution 2-D image of the 2-D planar substrate surface bearing said forms of graphical intelligence (e.g. symbol character strings). P

STEP 17: At the Image Processing Computer, use said OCR algorithm to perform automated recognition of graphical intelligence contained in said area-type high-resolution 2-D image of said 2-D planar substrate surface so as to recognize said graphical intelligence and generate symbolic knowledge structures representative thereof. Q

STEP 18: Repeat Steps 1-17 as often as required to recognize changes in graphical intelligence on the arbitrary moving 3-D object surface. R

FIG. 23C5

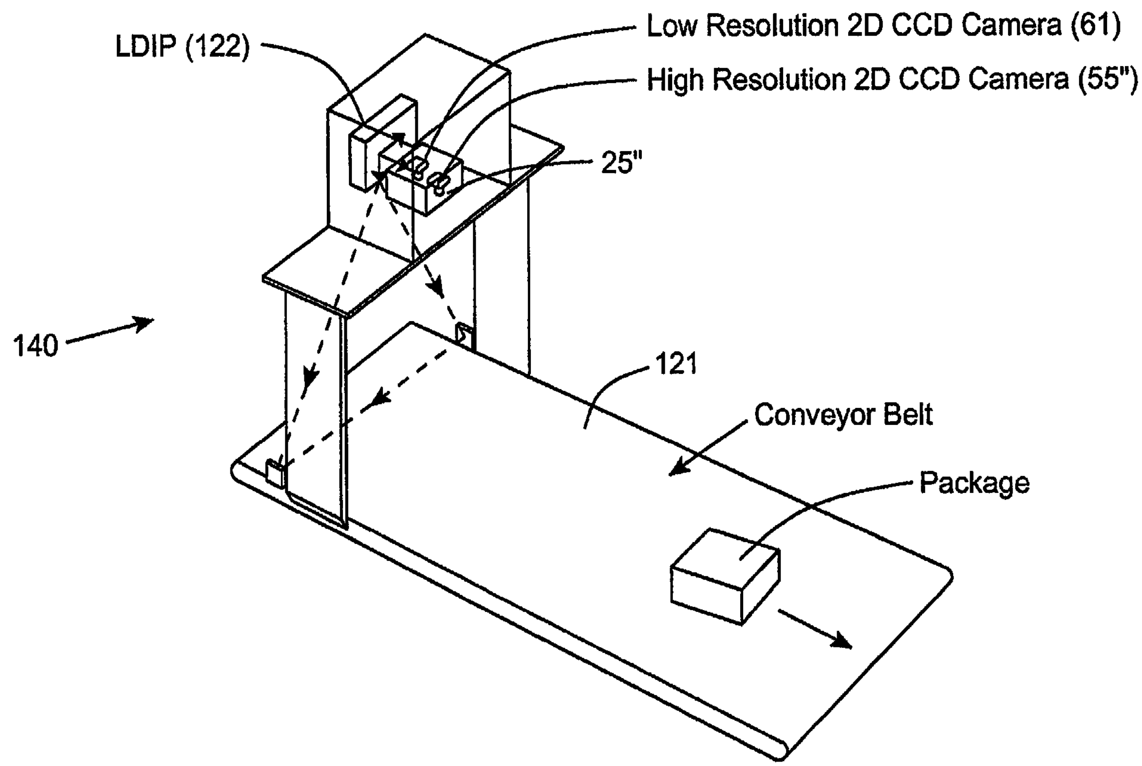

LDIP (122)
Low Resolution 2D CCD Camera (61)
High Resolution 2D CCD Camera (55")
25"
140
121
Conveyor Belt
Package

FIG. 24

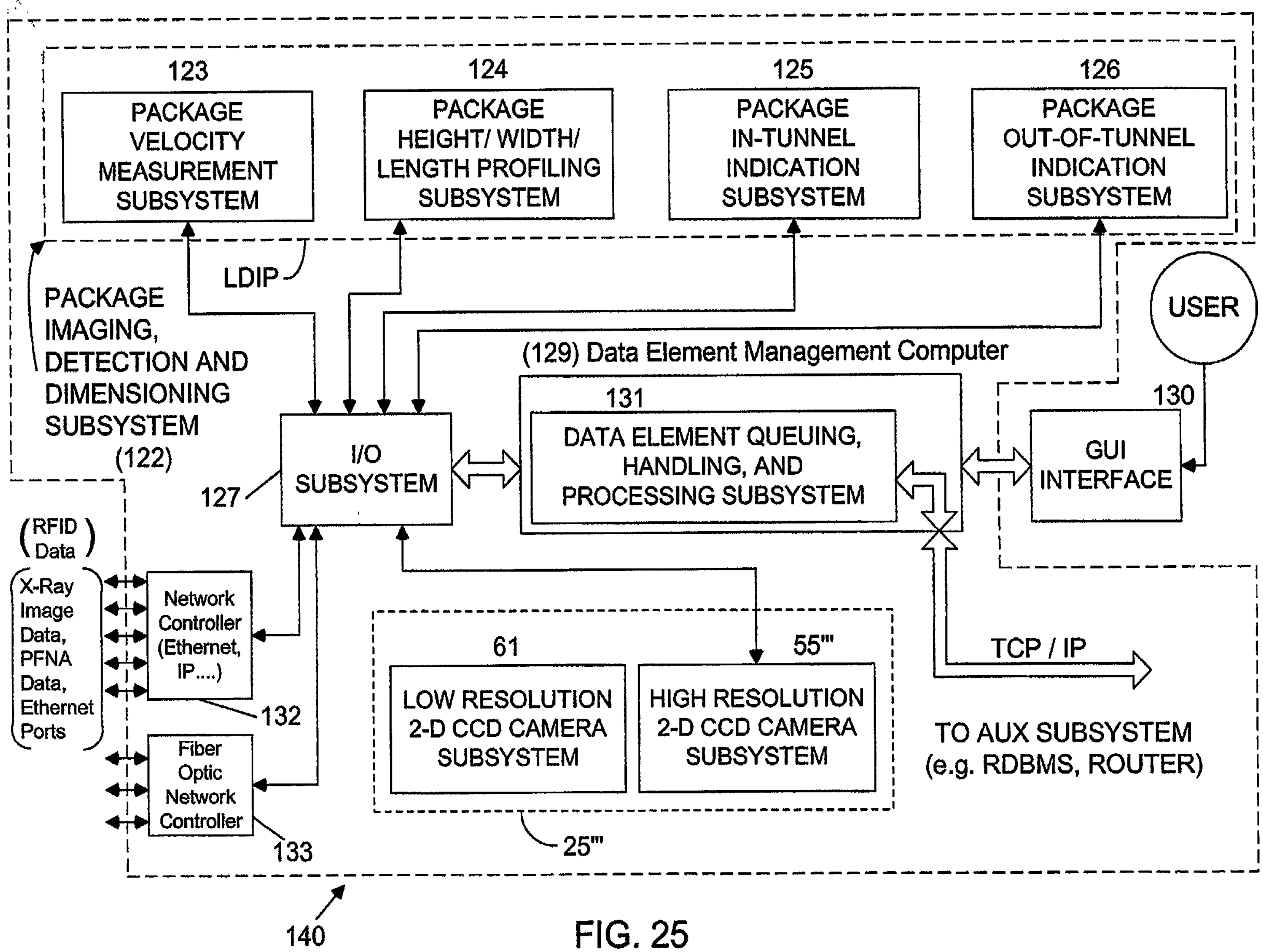

123
PACKAGE VELOCITY MEASUREMENT SUBSYSTEM
124
PACKAGE HEIGHT/ WIDTH/ LENGTH PROFILING SUBSYSTEM
125
PACKAGE IN-TUNNEL INDICATION SUBSYSTEM
126
PACKAGE OUT-OF-TUNNEL INDICATION SUBSYSTEM
LDIP
PACKAGE IMAGING, DETECTION AND DIMENSIONING SUBSYSTEM (122)
USER
(129) Data Element Management Computer
131
DATA ELEMENT QUEUING, HANDLING, AND PROCESSING SUBSYSTEM
130
GUI INTERFACE
127
I/O SUBSYSTEM
(RFID Data)
X-Ray Image Data, PFNA Data, Ethernet Ports
Network Controller (Ethernet, IP....)
132
Fiber Optic Network Controller
133
61
LOW RESOLUTION 2-D CCD CAMERA SUBSYSTEM
55'''
HIGH RESOLUTION 2-D CCD CAMERA SUBSYSTEM
25'''
TCP / IP
TO AUX SUBSYSTEM (e.g. RDBMS, ROUTER)
140

FIG. 25

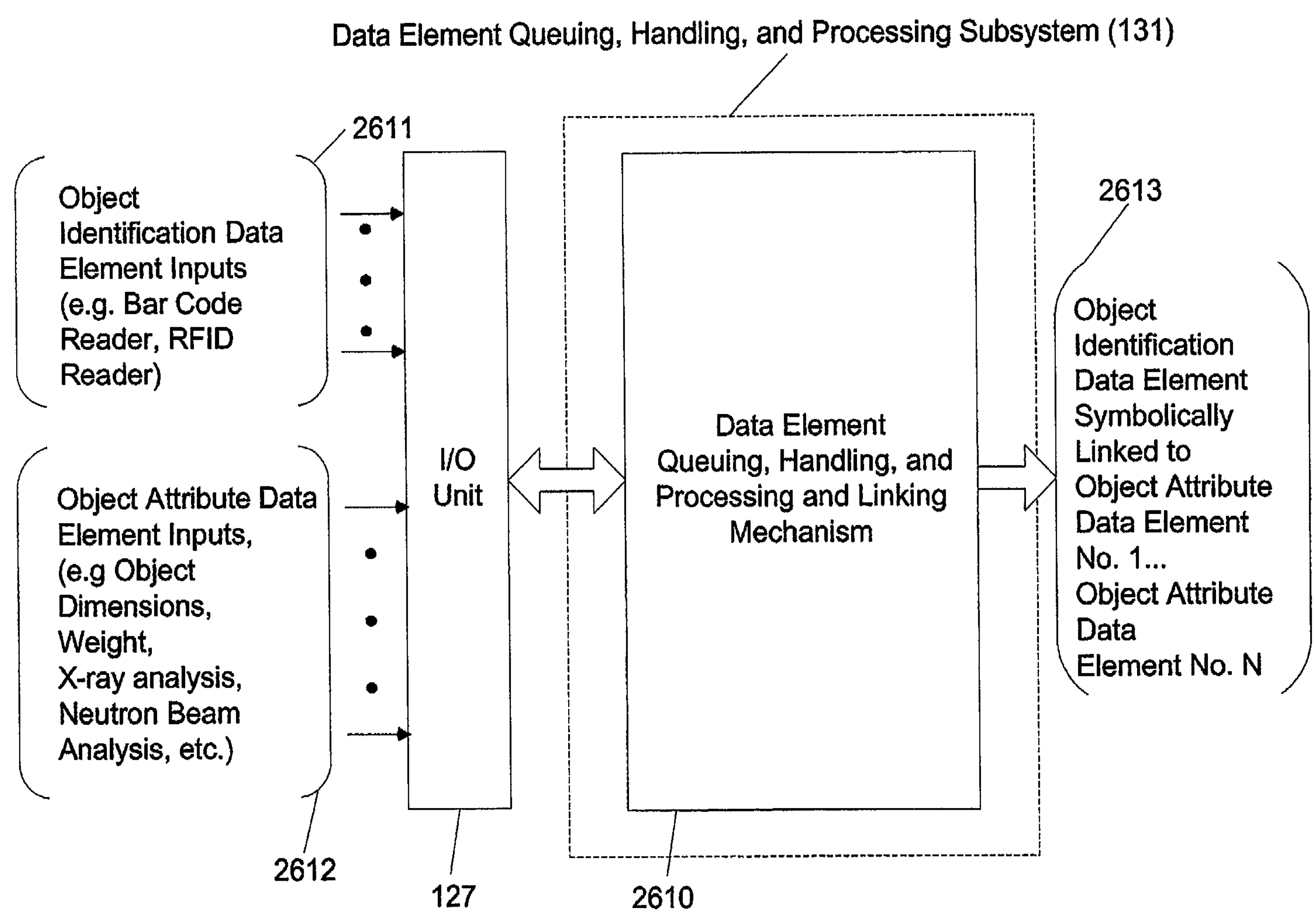
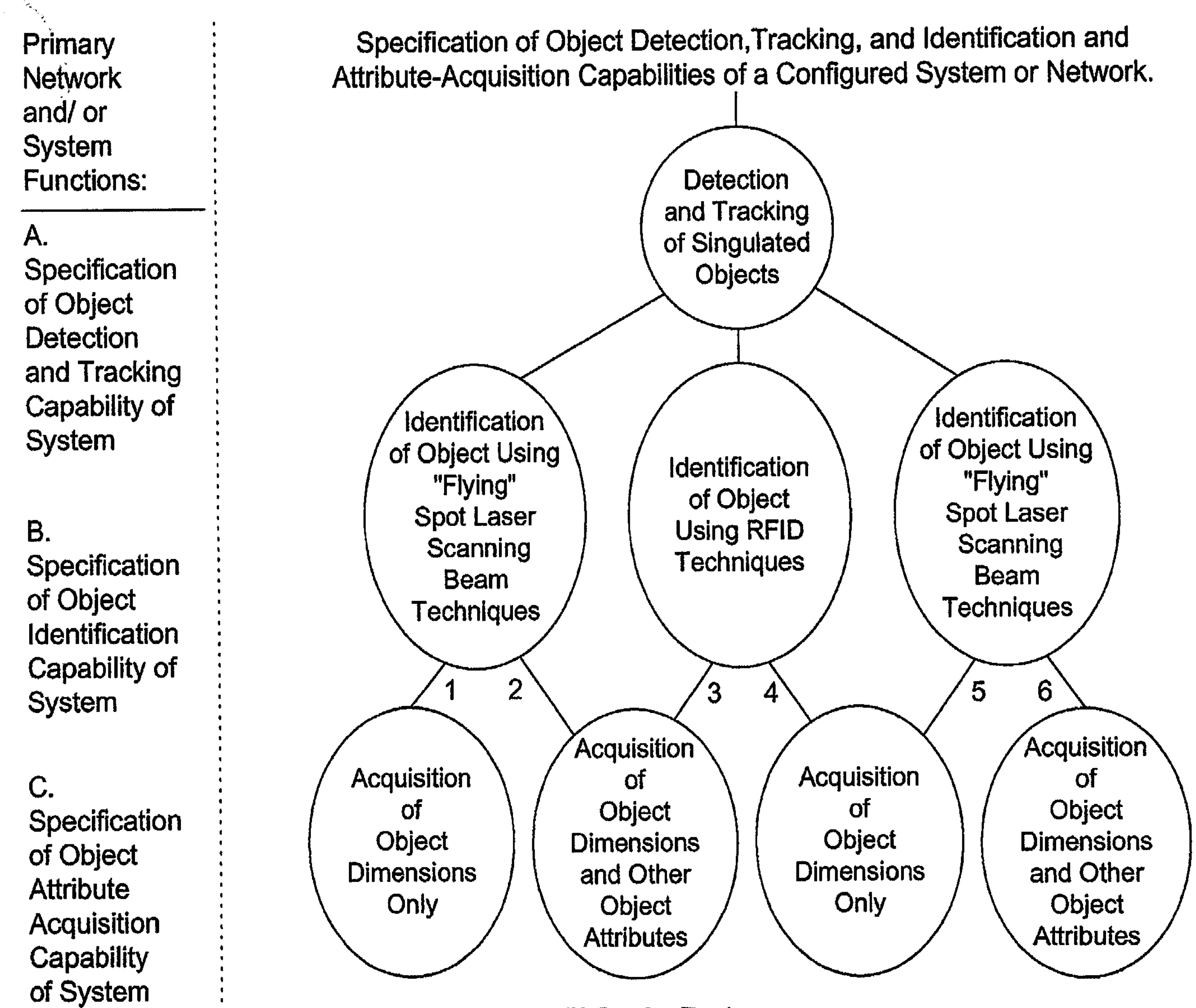

Data Element Queuing, Handling, and Processing Subsystem (131)
2611
Object Identification Data Element Inputs (e.g. Bar Code Reader, RFID Reader)
Object Attribute Data Element Inputs, (e.g Object Dimensions, Weight, X-ray analysis, Neutron Beam Analysis, etc.)
2612
I/O Unit
127
Data Element Queuing, Handling, and Processing and Linking Mechanism
2610
2613
Object Identification Data Element Symbolically Linked to Object Attribute Data Element No. 1... Object Attribute Data Element No. N

FIG. 25A



Primary Network and/ or System Functions:
A. Specification of Object Detection and Tracking Capability of System
B. Specification of Object Identification Capability of System
C. Specification of Object Attribute Acquisition Capability of System
Specification of Object Detection,Tracking, and Identification and Attribute-Acquisition Capabilities of a Configured System or Network.
Detection and Tracking of Singulated Objects
Identification of Object Using "Flying" Spot Laser Scanning Beam Techniques
Identification of Object Using RFID Techniques
Identification of Object Using "Flying" Spot Laser Scanning Beam Techniques
1
2
3
4
5
6
Acquisition of Object Dimensions Only
Acquisition of Object Dimensions and Other Object Attributes
Acquisition of Object Dimensions Only
Acquisition of Object Dimensions and Other Object Attributes

FIG. 25B-1

Primary Network and/ or System Functions:

A. Specification of Object Detection and Tracking Capability of System

B. Specification of Object Identification Capability of System

C. Specification of Object Attribute Acquisition Capability of System

Specification of Object Detection,Tracking, and Identification and Attribute-Acquisition Capabilities of a Configured System or Network.

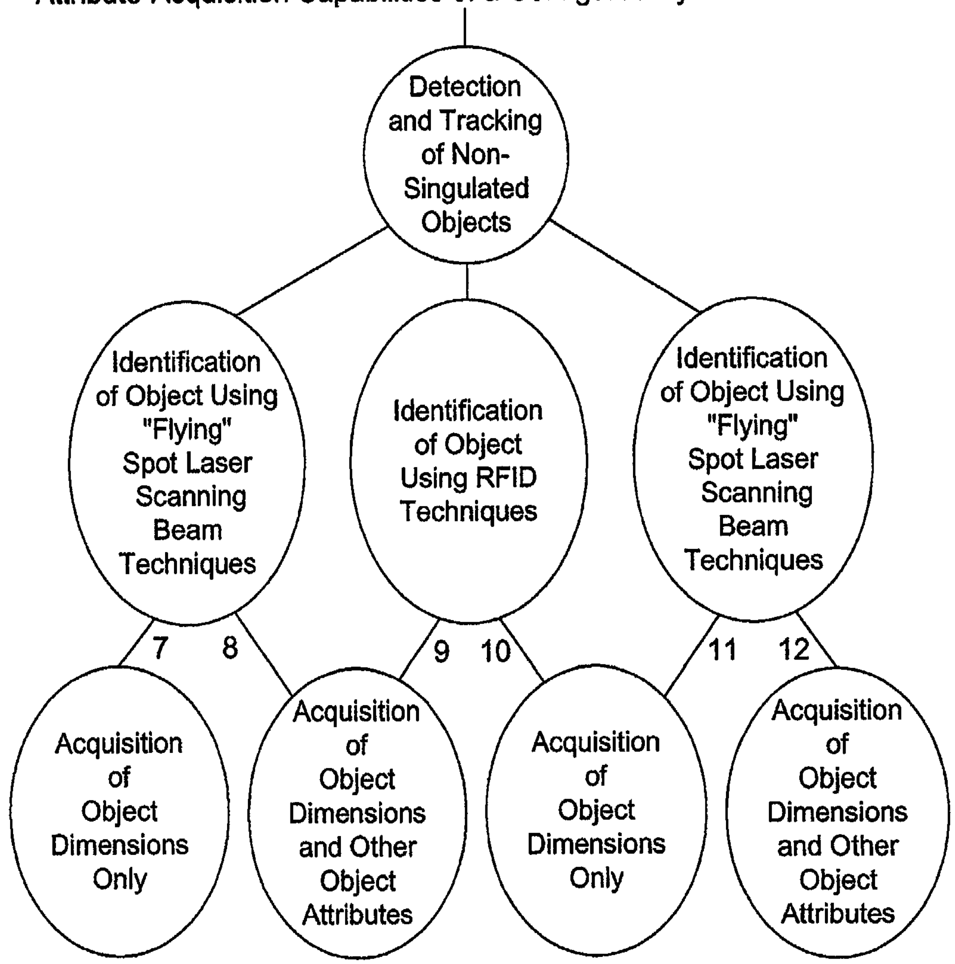


FIG. 25B-2

A — Specify object detection and tracking capabilities of PLIIM-based network, system, and/or subsystem.

↓

B — Specify object identification capabilities of PLIIM-based network , system, and/ or subsystems.

↓

C — Specify object attribute acquisition capabilities of PLIIM-based network, system, and/or subsystem.

↓

D — Determine the configuration of hardware components required to build the configured system or network.

↓

E — Determine the configuration of software components required to build the configured system or network.

↓

F — The system configuration manager program accesses the determined software components from its Software Library (e.g. maintained on an information server within the system engineering department), and compiles these software components with all other required software programs, to produce a complete System Software Package designed for execution upon a particular operating system supported upon the specified hardware configuration.

↓

G — The systems configuration manager program automatically generates an easy to follow set of Installation Instructions for the configured system or network, guiding the technician through an easy to follow installation and set-up procedure making sure all of the necessary system and subsystem hardware components are properly installed, and the system and network parameters are set up for proper system operation and remote servicing.

↓

H — Once the hardware components of the system have been properly installed and configured, the set up procedure properly completed, the technician is ready to operate and test the system for troubles it may experience, and diagnose the same with or without remote service assistance made available through the remote monitoring, configuring, and servicing system of the present invention, illustrated in Figs. 30A through 30D2.

FIG. 25C

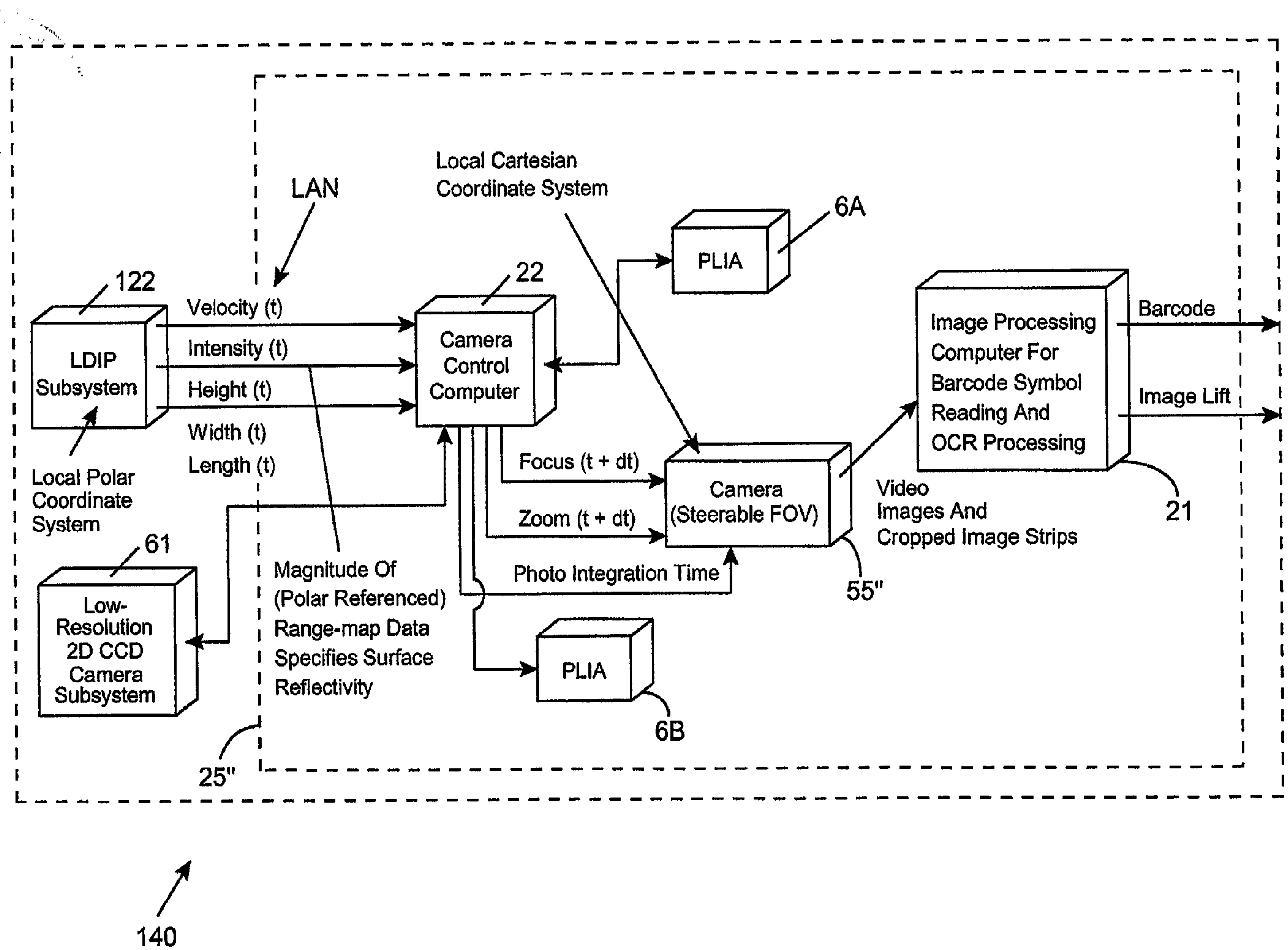

LAN
Local Cartesian Coordinate System
6A
PLIA
122
22
Velocity (t)
Intensity (t)
Height (t)
Width (t)
Length (t)
LDIP Subsystem
Camera Control Computer
Image Processing Computer For Barcode Symbol Reading And OCR Processing
Barcode
Image Lift
Local Polar Coordinate System
Focus (t + dt)
Zoom (t + dt)
Camera (Steerable FOV)
Video Images And Cropped Image Strips
21
61
Photo Integration Time
55"
Low-Resolution 2D CCD Camera Subsystem
Magnitude Of (Polar Referenced) Range-map Data Specifies Surface Reflectivity
PLIA
6B
25"
140

FIG. 26

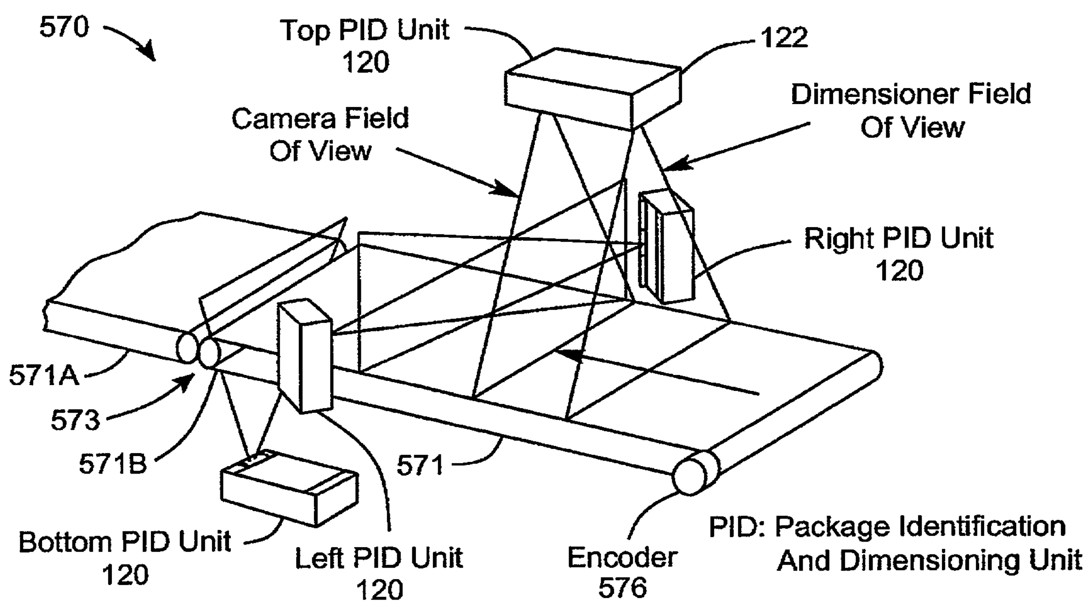

570
Top PID Unit
120
122
Dimensioner Field
Of View
Camera Field
Of View
Right PID Unit
120
571A
573
571B
571
Bottom PID Unit
120
Left PID Unit
120
Encoder
576
PID: Package Identification
And Dimensioning Unit

FIG. 27

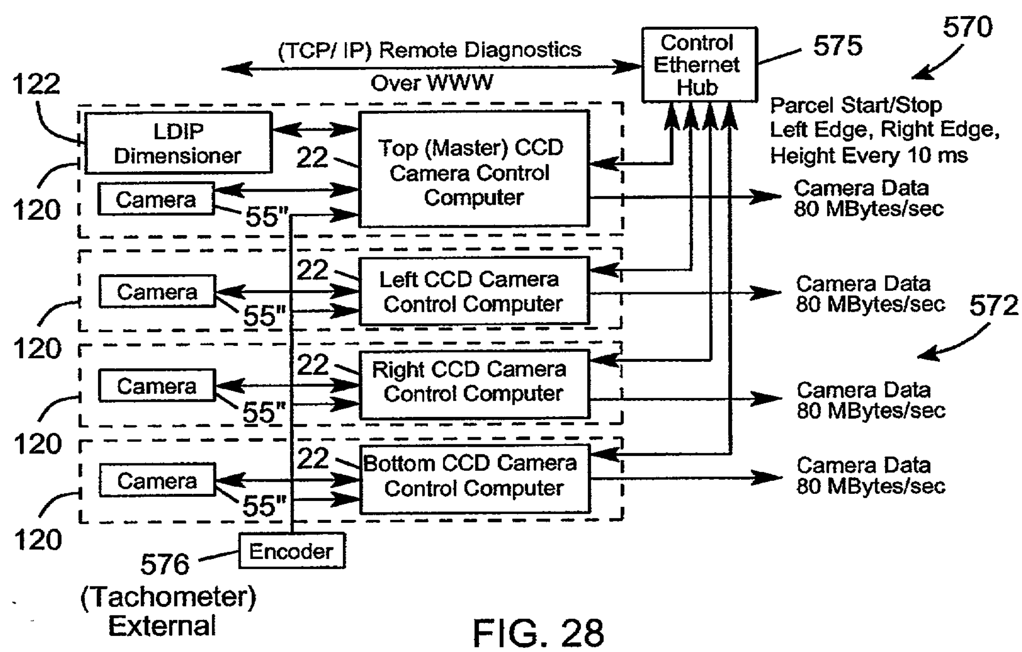

(TCP/ IP) Remote Diagnostics
Over WWW
Control
Ethernet
Hub
575
570
122
LDIP
Dimensioner
22
Top (Master) CCD
Camera Control
Computer
Parcel Start/Stop
Left Edge, Right Edge,
Height Every 10 ms
120
Camera
55"
Camera Data
80 MBytes/sec
22
Camera
Left CCD Camera
Control Computer
55"
Camera Data
80 MBytes/sec
572
120
22
Camera
Right CCD Camera
Control Computer
55"
Camera Data
80 MBytes/sec
120
22
Camera
Bottom CCD Camera
Control Computer
55"
Camera Data
80 MBytes/sec
120
576
Encoder
(Tachometer)
External

FIG. 28

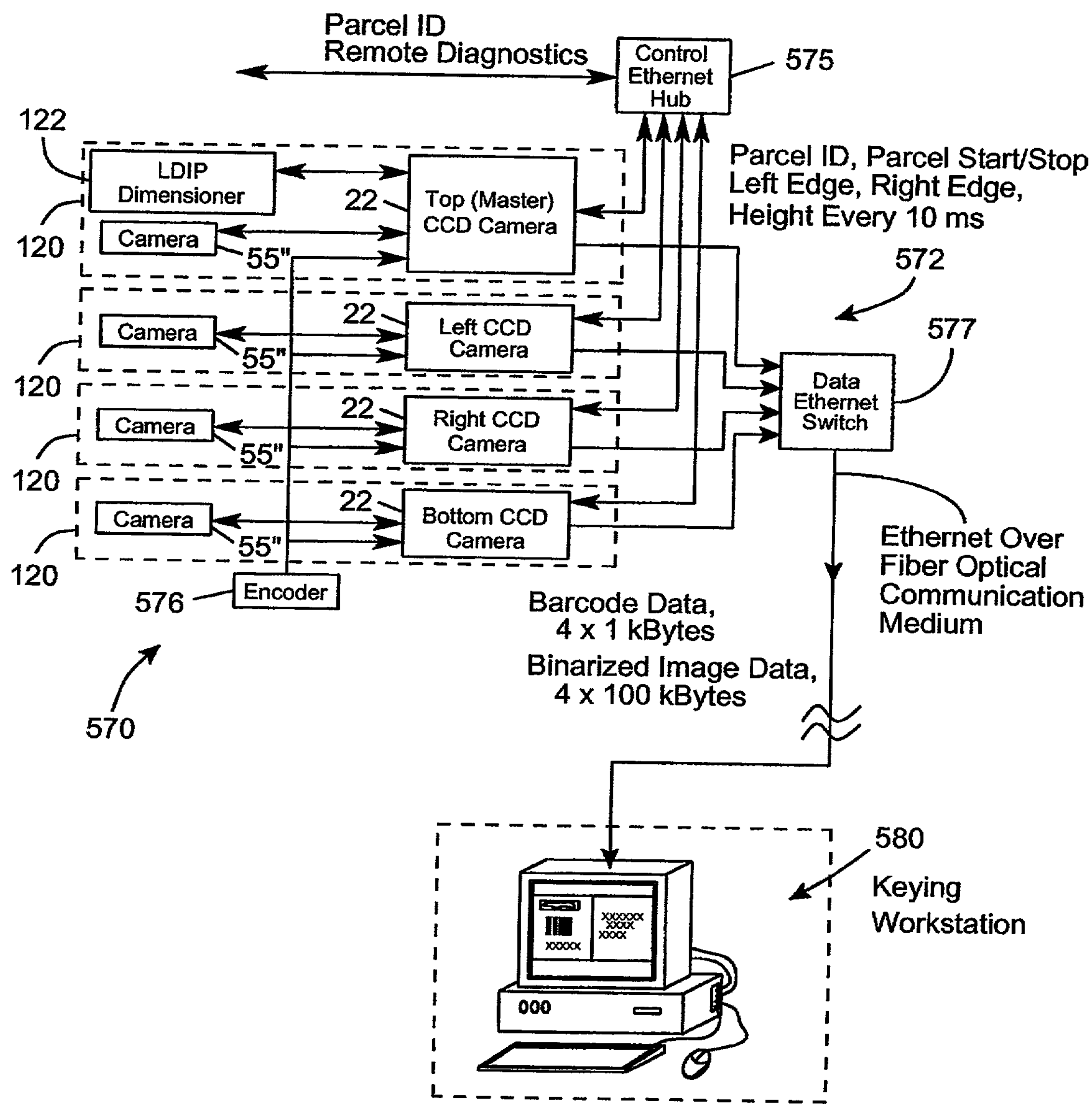

Parcel ID
Remote Diagnostics
Control Ethernet Hub
575
122
LDIP Dimensioner
22
Top (Master) CCD Camera
120
Camera
55"
Parcel ID, Parcel Start/Stop
Left Edge, Right Edge,
Height Every 10 ms
572
577
Camera
22
Left CCD Camera
55"
120
Data Ethernet Switch
Camera
22
Right CCD Camera
55"
120
Camera
22
Bottom CCD Camera
55"
120
Ethernet Over
Fiber Optical
Communication
Medium
576
Encoder
Barcode Data,
4 x 1 kBytes
Binarized Image Data,
4 x 100 kBytes
570
580
Keying
Workstation

FIG. 29